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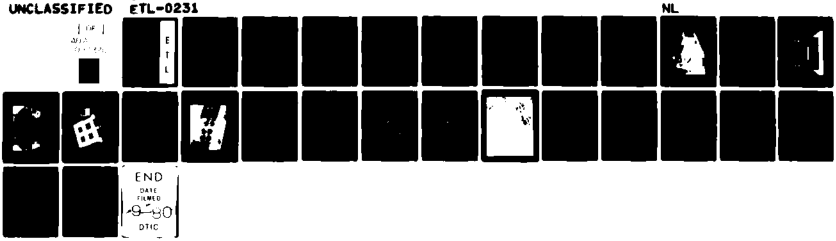

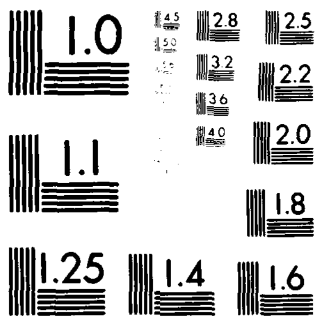


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# Terrain analyst synthesizer station

Gunther Schwarz

ADA087370

JUNE 1980



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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes the Terrain Analyst Synthesizer Station built under contract for USAETL. Tests were performed to determine the characteristics and adherence to the specifications set forth in the Purchase Description.

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# PREFACE

This study was conducted under DA Project 4A762707A855, Task C, Work Unit 00021, "Topographic and Geographic Technology."

The study was done during October 1979 under the supervision of Mr. Alexander Pearson, Group Leader, Topographic Products Group; Mr. A. C. Elser, Chief, MGI Data Processing and Products Division; and Mr. K. T. Yoritomo, Director, Geographic Sciences Laboratory.

COL Daniel L. Lycan, CE, was Commander and Director and Mr. Robert P. Macchia was Technical Director of the Engineer Topographic Laboratories during the study and report preparation.

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## TERRAIN ANALYST SYNTHESIZER STATION

### INTRODUCTION

This report covers the engineering tests of the Terrain Analyst Syntherizer Station (TASS).* The purpose of the tests was to determine (1) the operational performance characteristics and (2) compliance with the technical requirements as stated in appendix A.

The terrain analyst performs three functions, (1) the extraction of information from imagery and collateral sources of information, (2) the preparation of factor overlays, and (3) the complexing of overlays to produce products. The present methods for complexing factor overlays is to stack various full size transparent factor overlays on top of each other on a light table. The analyst then combines and records on a registered overlay the particular factors applicable to his final product. With all the various overlays stacked on top of each other, it is difficult to determine from which overlay the information originates, which is a requirement when combining the information. Also, it is easy to overlook an area or factor of interest.

The TASS was developed to assist the terrain analyst and to provide a simplified capability to Army topographic units as an interim means for producing complexed factor overlays. The TASS was built under contract DAAK70-78-C-0201, dated 30 September 1978 by the International Imaging Systems ($I^2S$) Division of Stanford Technology Corporation (STC), Sunnyvale, California. STC negotiated a subcontract with Matra Technology, Inc., Los Gatos, California for fabrication of a viewing/tracing table and appropriate interface modifications to the $I^2S$ multispectral viewer. The TASS was delivered to ETL on 24 September 1979 for test and evaluation.

* Originally, TASS was called the Map Compositor and Display Projector (MCDP).

## INVESTIGATION

**GENERAL DESCRIPTION** • The TASS (figure 1) has two basic components: (1) a modified $I^2S$ multispectral viewer/projector, and (2) the viewing/tracing table. Both components are joined together by a set of steel channel beams. The TASS dimensions are 200 cm (centimeters) long, 136 cm high, and 86 cm wide. It has the capability to project and superimpose four factor film chips onto the viewing/tracing table. The table can be moved so that a 9X to 12X continuous magnification of the factor chips is possible.

**PROJECTOR** The projector is a standard multispectral viewer that has been modified to include remote operator controls and magnification capability. The images can be projected in color by rotating filter wheels containing color filters in each light path. Channels 1, 2, and 3 have red, green, blue and clear filters, and channel 4 has a yellow filter substituted for the blue filter. Two of the four optical paths are shown in figure 2. The light originates with a DAH 500 watt lamp, passes through a heat-absorbing glass that reduces the heat transferred to the film, and then passes through the filter and condenser system. The filtered light illuminates the film chips, which are held in place by glass platen, proceeds through a Schneider Componon-S 150 mm, f 5.5 lens, and is reflected by the first mirror out of the projector. The light is then reflected by a second mirror located under the viewing/tracing surface through the clear glass stage onto a mylar base tracing sheet or rear projection screen. The viewer controls are grouped in different areas of the system.

1. Film loading controls, rotational (theta) registration are located on the front of the projector (figure 3)
2. The individual channel on/off switches, illumination controls and X–Y registration controls are located on the main panel of the tracing table (figure 4).
3. The exposure controls (figure 3) for each individual channel are located on the upper front panel of the projector.

The theta plate (figure 5) has four film chip holders, each with a glass 65-mm-square aperture. The holders are designed to accomdate 70 mm chips. This subassembly is located directly below the upper housing of the projection. Controls to rotate the images are attached directly to the theta plate.

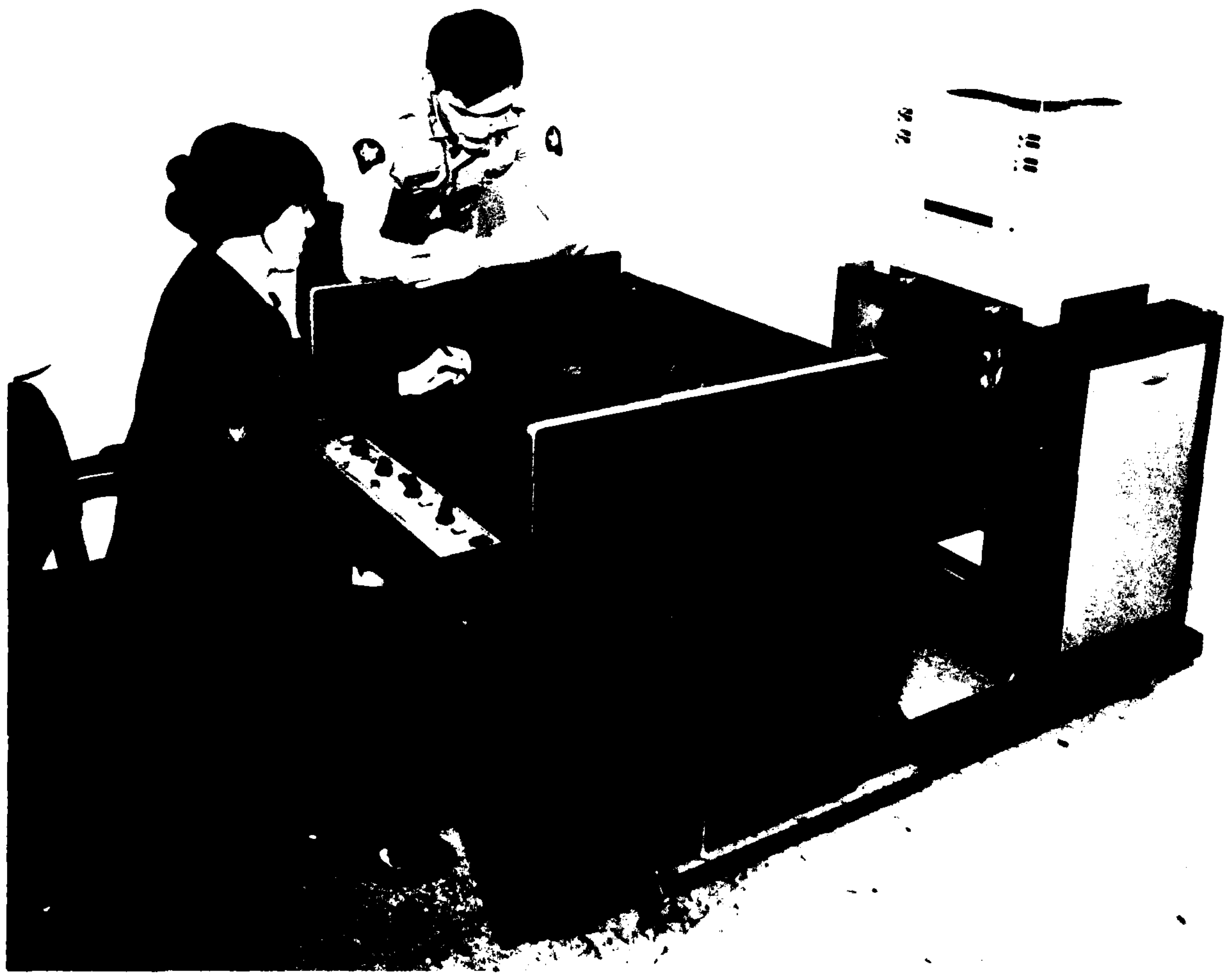


**FIGURE 1.** Terrain Analyst Synthesizer Station.

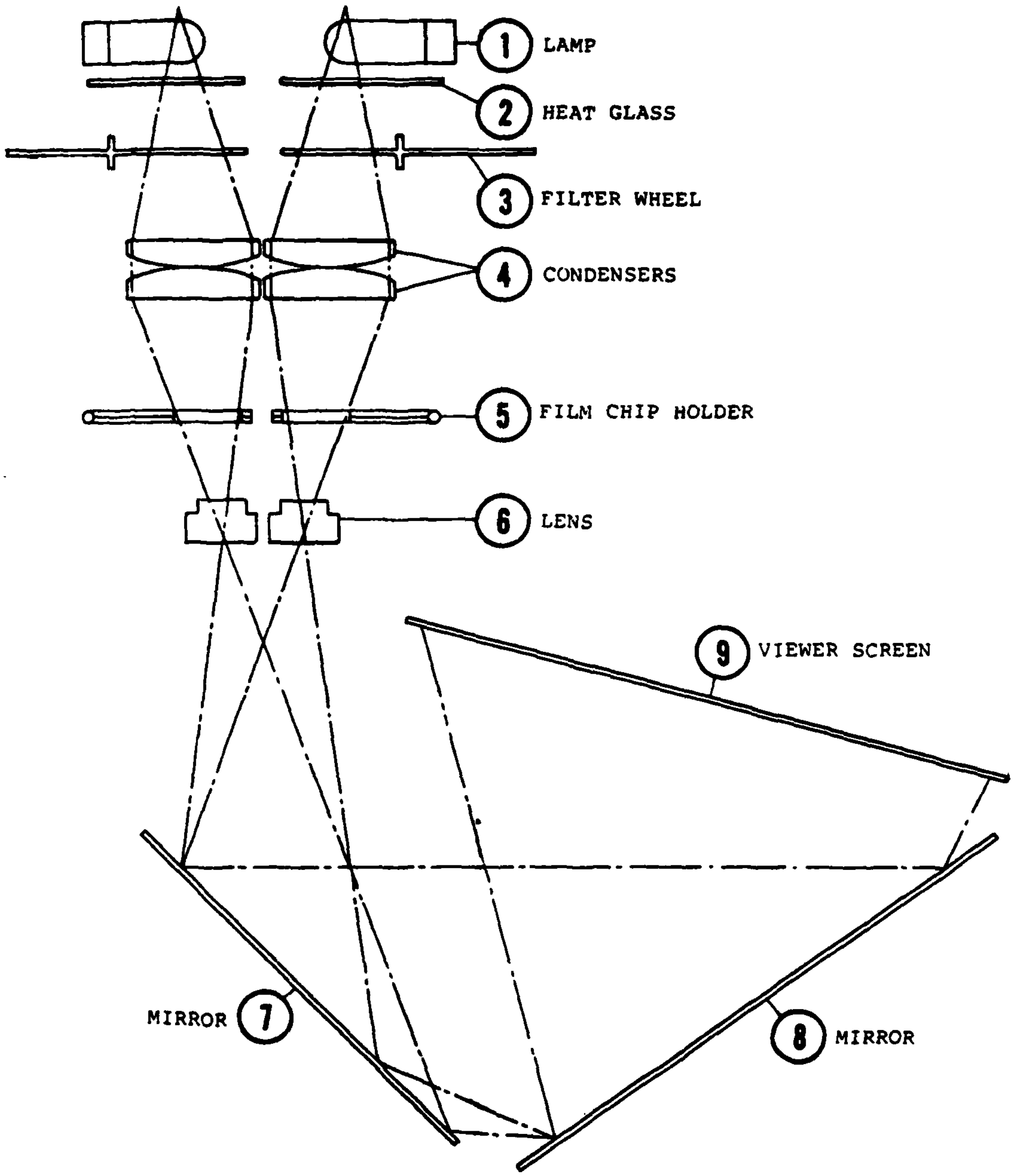



**FIGURE 2.** Optical Schematic.

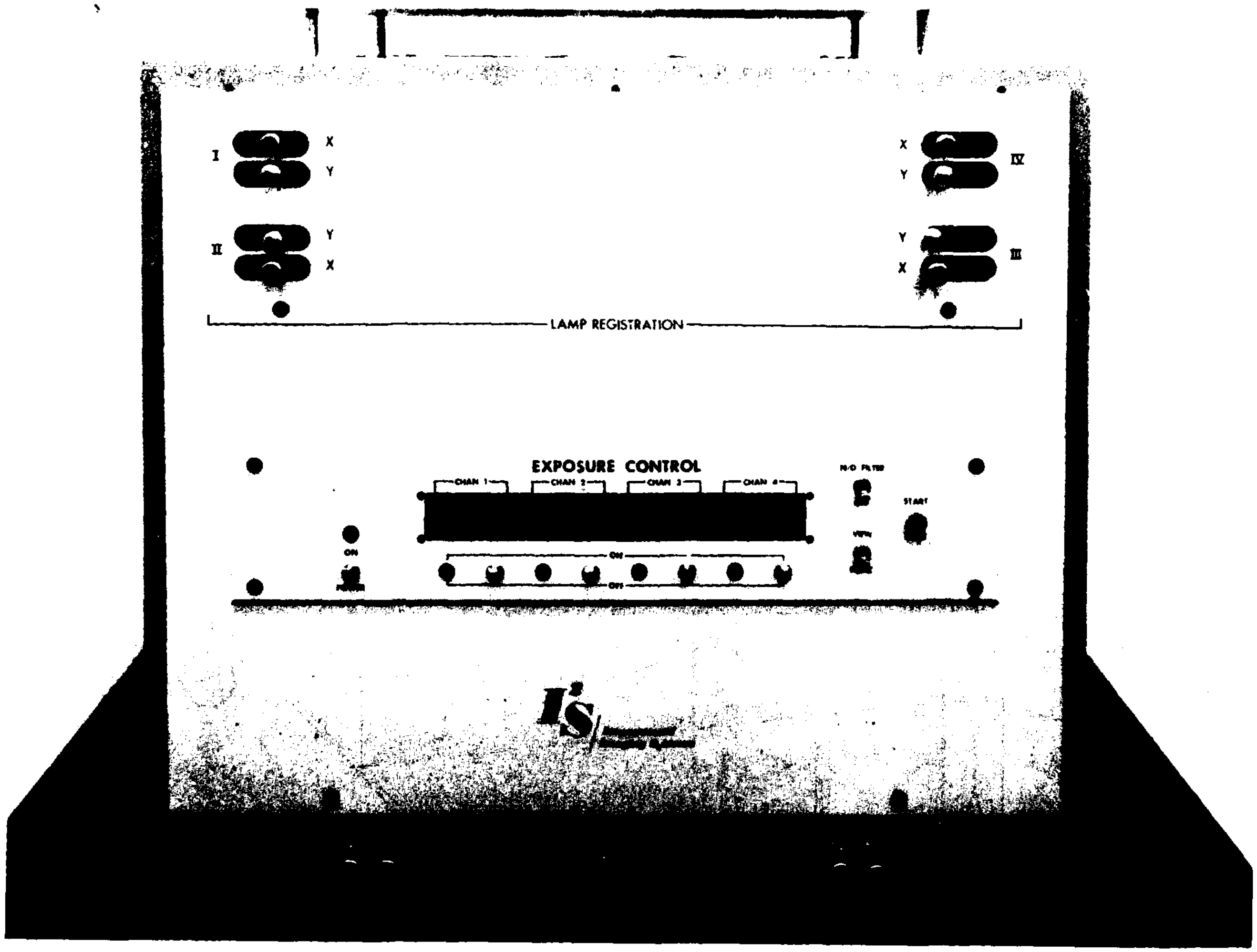



FIGURE 3. Upper Front Control Panel.

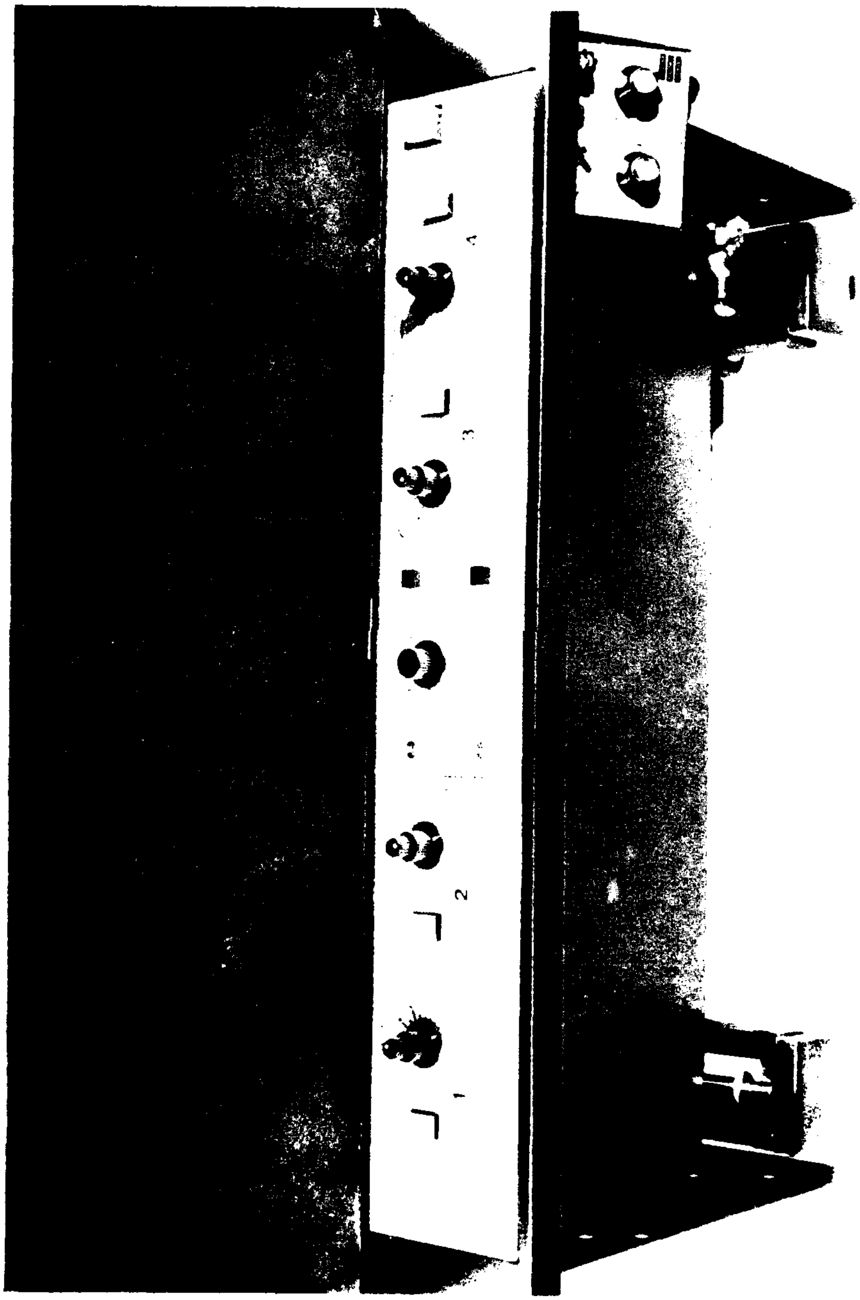


FIGURE 4. Main Control Panel.

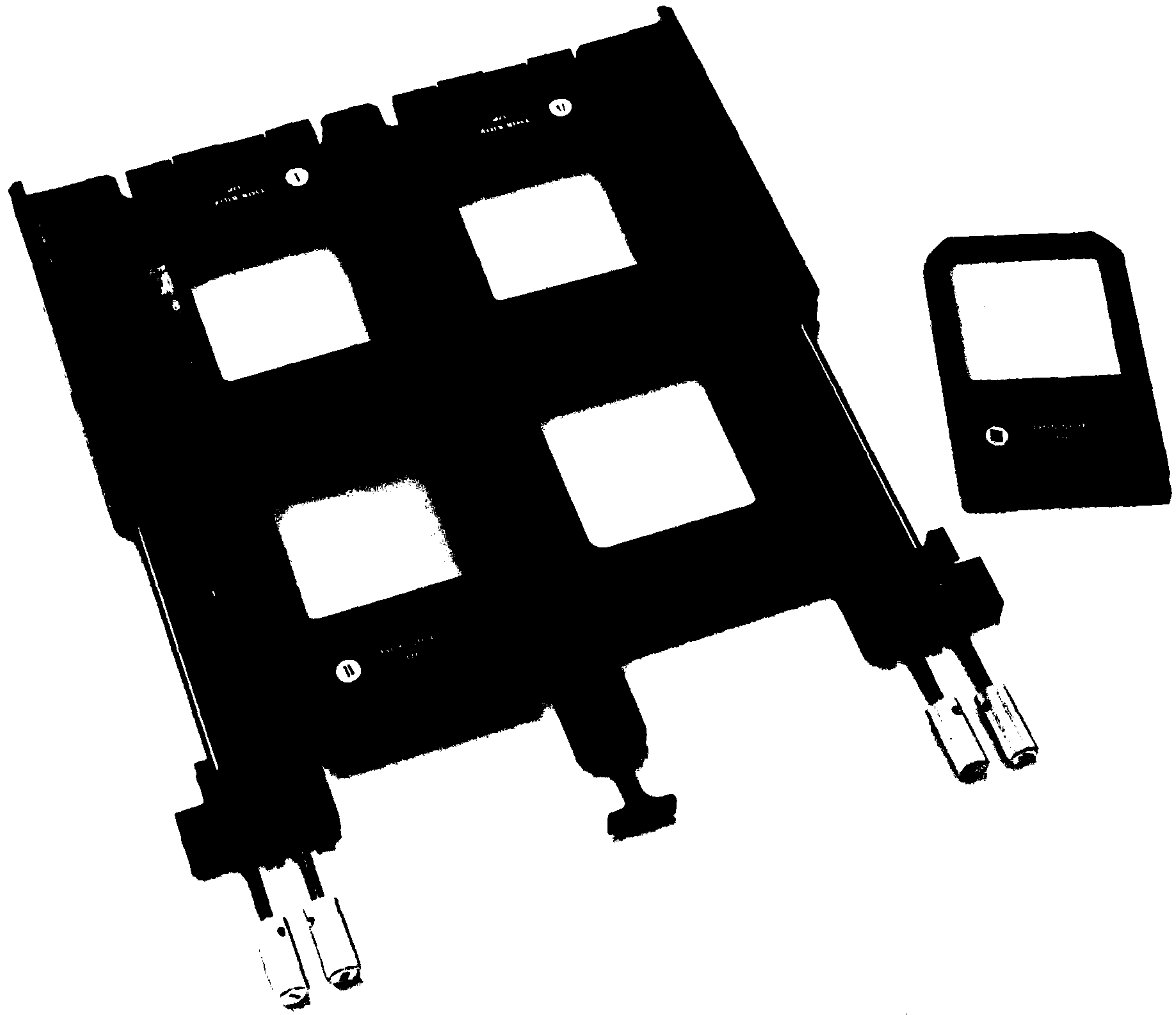


FIGURE 5. Theta Plate with Film Holders.

With the exposure control unit, the operator can vary the exposure for each channel individually from 0.1 to 99.9 seconds. The controls are mounted on the upper front panel of the projector. Incorporated into the exposure control is a switch that enables the operator to insert electronically a 4.0 neutral density filter into each light path.

**TRACING TABLE** The tracing table is mounted on a guiding stainless steel way-and-roller assembly, which enables the operator to move the table closer to or further away from the projector to change the magnification of the projected image. To focus the image after the magnification scale is changed, a focus control module is mounted on the table. This module operates the raising or lowering of the lens mounting plate in the projector. The viewing part of the table is a clear glass area of 27 by 22 inches (69 by 56 cm) covered by a mylar-base tracing material. A Harris registration bar is mounted above the glass to register the overlays being imaged on the mylar tracing sheet. Below the glass is the second front surface mirror (see figure 2). This mirror is 25 by 30.5 inches (64 by 78 cm) and is mounted on a three point suspension mount. This allows precise alignment of the projected image in relation to the original. Directly in front of the operators position are the main power switch, individual channel on/off switches, illumination controls, and the X–Y registration control. This control consists of a three-position (horizontal, vertical, and standby) toggle switch, a channel selector, two drive buttons (one for right-up and one for left-down directions), and a slew-jog switch. These switches activate the drive motors for the X and Y translation of the lenses. There are a total of eight motors (figure 6), one each for X and Y directions of each lens. A rubber pressure mat is attached to the table to keep the photographic film flat and in contact with the Mylar tracing material.

FIGURE 6. Stepper Motors for X–Y Control.

**PRINCIPLE OF OPERATION** • The TASS is operated as follows: First, negative film factor chips are placed in the film chip holders. Next, the power is turned on, and the individual projected images are color coded by means of the filters. After two channels are turned off, the other two channels are superimposed by means of the X–Y and theta controls. After these two channels are registered, one channel is turned off and a third one is turned on. This channel is then superimposed on the first channel. This procedure is followed until all four channels are registered on the mylar base material on top of the glass table top. Then, the operator proceeds to compile a complex factor overlay by blocking out those lines with a special marking pen of areas not required to be shown on the overlay. Once this process is completed, the color filters are dialed out of the light path, and the required exposure is set on the timer. A piece of photographic film is placed on top of the mylar material, and the rubber mat is placed over the film. When the exposure button is pushed, each channel is illuminated for the preselected time. After processing the film, the result is a complexed factor overlay for a 1:50,000–scale topographic map.

## TESTS AND RESULTS

In the first test, the optical alignment of the four channels and the two mirror surfaces was determined.

**OPTICAL ALIGNMENT** • A 12X magnification precision-reduced film copy of a grid was placed in each of the four channels. The grids were then projected and registered. The copies were enlarged so that they matched the size of the original grid, which was placed on the viewing surface. The master grid has 10-mm–line intervals.

**RESULTS** The first attempt to match the master grid failed owing to a lack of adjustment in the second mirror. After making the necessary adjustment, the operator was able to match the projected image to the original grid without any noticable disortion over the entire 22- x 27–inch (56– by 59–cm) area. Channel registration was well within the acceptable limits of one line width over the viewing area.

**PHOTOGRAPHIC REPRODUCTION** • For this test, a set of factor chips depicting vegetation, soil, drainage, and culture was projected. After registration of the images was completed, the filter wheels were rotated so that white light was projected. A piece of Kodalith Type 3 film was placed on the mylar base tracing material and an exposure was made. The film was processed in the normal manner. This was repeated until the correct exposure was determined.

**RESULTS** The correct exposure was 45 seconds with the neutral density filters in place. The result and overlay matched the topographic map sheets within acceptable limits.

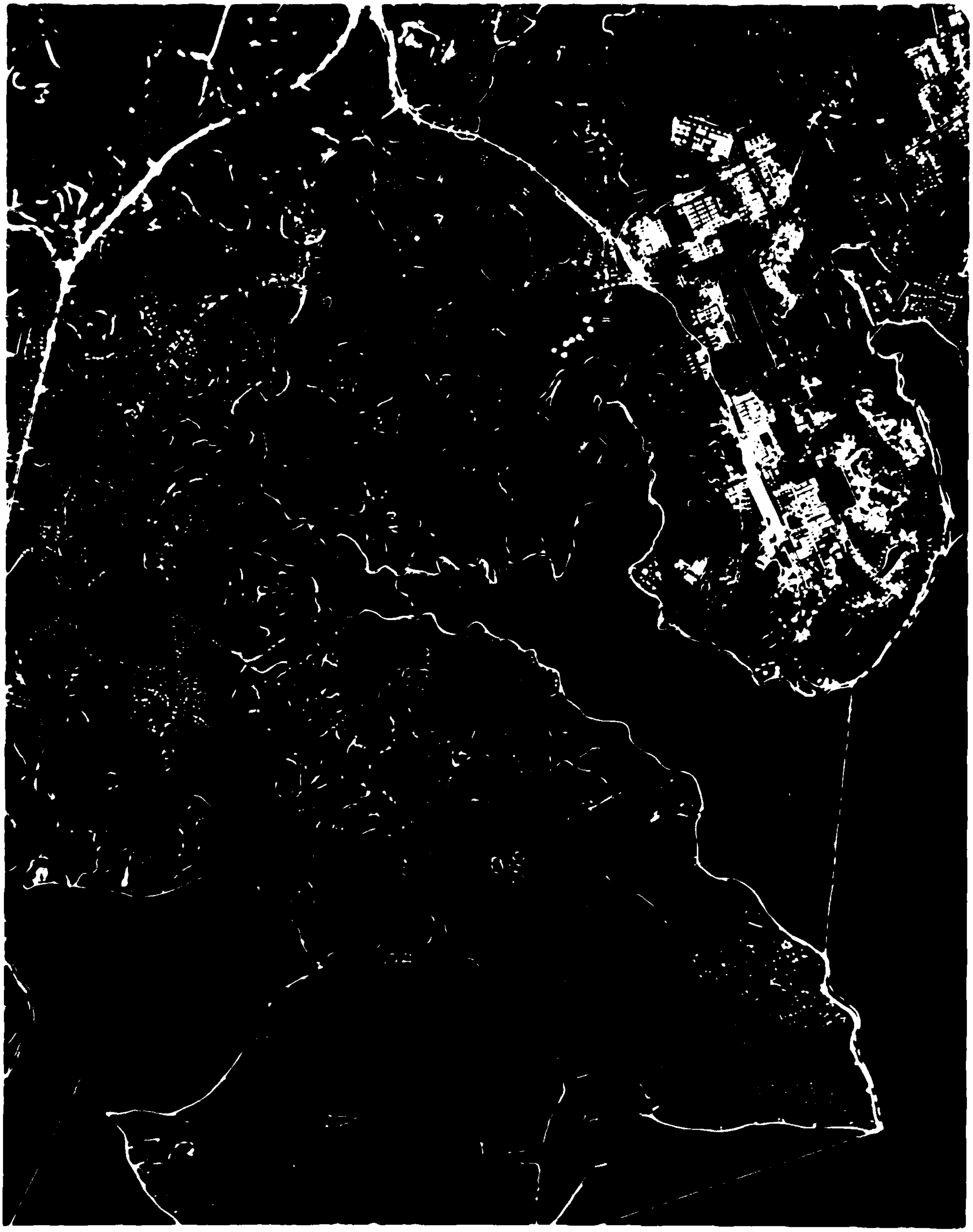
The above test was repeated with some projected lines blacked out on the mylar tracing material. The results of this test can be seen in figures 7 and 8. A color print was made to show the reader what the analyst sees (figure 9).

**MAGNIFICATION SCALE** • A set of 9X reduced copies of a grid was placed in the viewer, projected on the viewing table, and matched to the master grid. This procedure was repeated with a set of 12X reduced grids.

**RESULTS** In each case the projected image was matched to the original.

**FIGURE 7.** Factor Overlay Before Deletion of Data.

FIGURE 8. Factor Overlay After Deletion of Data.



## DISCUSSION

The Terrain Analyst Synthesizer Station was tested at ETL to determine if the contractor had met the requirements set forth in the Purchase Description (appendix A). In testing the optical alignment of the four channels, the complete optical system from projection lamp to viewing surface was checked. Although it was not specified in the Purchase Description, the manufacturer's specifications required that the image matching must be accurate within one line width (.001 inch or .03 mm). This accuracy requirement was met.

The first tests, however, did not allow the projected grid image to align correctly to the master grid. After some adjustments of the three point support of the second mirror, the projected grids were matched with the master grid on the viewing surface. The results of this test showed that the overall distortion, as well as incremental distortions, was well within the acceptable limits.

The reproduction of the complexed factor chips is basically a photographic operation. Therefore, the exposure time could change depending on the type of film used and the density of the projected image. During this phase of the tests, it was noted that the actual exposure time was approximately one-half of the time set into the exposure control. This problem was solved with an adjustment on one potentiometer in the exposure control circuit.

The magnification capability of the system was checked by projecting a set of grids at each extreme of the magnification scale (9X to 12X). There was no problem in meeting the required magnification, nor was there a problem in focusing the image at either extreme. The operations of the TASS, such as the registration of the images by means of remote control X–Y offset, are relatively easy to accomplish. The human engineering requirements of the system are acceptable. The operator had no problems in seeing the image on the viewing table, nor did he have any difficulfy in making his cartographic corrections on any part of the viewing screen.

Since the basic multispectral viewer concept was not changed with the modifications and additions, it was decided to project a set of LANDSAT images. The results were very good. The image, even though the magnification was 12X, did not "fall apart," but apeared to be sharp and easily registered.

Another application was a three-dimensional (stereo) projection of aerial imagery. For this purpose, a set of positive aerial images with 60 percent overlap was projected, one in red the other in blue, and lined up on the viewing screen in such a way that when viewed through a set of red and blue (multiplex) glasses, a dramatic stereo effect was visible. Also, the viewer can be used as a photographic enlarger, providing the enlargements are within the magnification range of the system.

## CONCLUSIONS

It is concluded that

1. The Terrain Analyst Synthesizer Station (TASS) meets all requirements as stated in the Purchase Description.

2. This development proved the technical feasibility of optically complexing factor overlays to synthsize another product.

3. Although it was not the initial intent of this development, the instrument is capable of projecting LANDSAT and aerial photographic imagery.

## APPENDIX A

## U.S. ARMY ENGINEER TOPOGRAPHIC LABORATORIES

## PURCHASE DESCRIPTION

21 April 1978

## MAP COMPOSITOR AND DISPLAY PROJECTOR (MCDP)

1. **Scope.** This Purchase Description defines the requirements for the design and fabrication of a compositor–projector system to be used in complexing factor overlays and other terrain analyst functions.

2. **Background.** The terrain analyst performs three functions: The extraction of information from imagery and collateral sources of information, preparation of factor overlays, and the complexing of overlays to produce products. The present method for complexing factor overlays is to stack various full size transparent factor overlays on top of each other on a light table. The analyst then combines and records on a registered overlay those particular factors applicable to his mode. With all of the various overlays stacked on top of each other, it is difficult to determine which overlay information go together and not accidently overlook an area or factor of interest. This method is a very laborious, time consuming procedure. This purchase description describes a simple to operate mechanical/photo/optical instrument for field army use. This instrument would permit rapid synthesizing of terrain factor overlays thereby saving valuable time.

3. **Requirements.**

3.1 **Compositor–Projector.** The compositor–projector must be capable of projecting four 70mm factor map chips simultaneously to a horizontal rear.projection screen mounted on an attached table like device. The projector shall be able to superimpose these four images on the screen using the corner reference marks from each factor map chip. Three of the projection channels shall have a set of rotating filters consisting of red, green, blue and clear. The fourth channel shall have a yellow filter substituted for the blue filter. The viewer table must be such that a projected image of approximately 21 x 26 inches can be viewed on the viewing surface. The image to be focused through clear plate glass or equivalent. Thickness of the glass must be such that the structural integrity is upheld. The surface closest to the focusing side and down to a level of 5 mm below the surface must be without scratches, bubbles, or other imaging interference defects. A GFE registration bar will be loaned to the contractor for the purpose of exact distance measurements.

3.1.1 **Magnification.** The viewer table shall be able to move in such a manner as to be able to make magnification changes from 9X – 12X. The projection lenses in the projector system must be able to focus the images over this magnification range.

3.1.2 **Photographic Copy Capability.** In order that photographic copy of the final factor map product can be made a removable pressure platten, capable of holding a piece of photographic film 22 x 28 inch minimum in contact with the viewing surface, must be furnished.

3.1.3 **Controls.** The following controls of all four channels must be remoted to the operator's work station at the viewer table. X, Y, and Ø motion, filter control, on/off switch, focusing control. The main power switch may be located either on the projector or table part of the MCDP. All control switches, knobs, buttons, etc., must be easily accessible from the operator's working station.

3.1.4 **Dimensions.** The maximum dimensions of the system shall be more than 90 x 42 inches at the 12X magnification scale. The viewing surface shall be no more than 36 inches from the floor.

3.2 **Instruction Manuals.** Four sets of instruction manuals for the MCDP system, including trouble shooting techniques, shall be furnished.

3.3 **Human Engineering.** The above system shall be built in accordance with good human engineering practices. Human factor engineering considerations shall include, but not be limited to, the following factors: Environmental conditions, safety including electrical and mechanical, display and control panel layout, labeling component arrangement, and accessibility for maintenance.

3.4 **Reliability.** The system shall provide maximum possible inherent reliability consistent with existing state-of-the-art and shall demonstrate, to the satisfaction of the Government, that a high degree of system reliability has been attained.

3.5 **Standard Products.** Where feasible, components shall be standard commercial products so that prompt and continuing service and delivery of spare parts may be assured.

3.6 **Instruction Plates.** The system shall be equipped with instruction plates, including warnings, cautions, suitably located, describing any special or important procedure required for operating and servicing.

3.7 **Workmanship.** Workmanship shall be in accordance with good commercial practice for this type of equipment.

4. **Quality Assurance Provision.**

**Inspection.** The system shall be subjected to inspection by Government representatives during and after manufacture to determine conformance with the requirements of this Purchase Description.

## APPENDIX B

## PLAN OF TEST

## FOR

## TERRAIN ANALYST SYNTHESIZER STATION

1. **PURPOSE.** The purpose of this test is to determine the capability of the Map Compositor and Display Projector (TASS) to combine several factor overlays and to reproduce the completed factor overlays as a single factor map to be used in conjunction with a standard 1:50,000 topographic map.

2. **REFERENCES.**

2.1 Purchase Description – Map Compositor and Display Projector dated 21 April 1978.

2.2 U.S. Army MERADCOM Contract No. DAAK79–78–C–0201.

3. **PLAN OF TEST.**

3.1 General. Tests of the TASS will consist of an optical alignment test, Operational Test for 9x – 12x magnification, photographic reproduction test, ease of operation and maintenance.

3.2 Optical alignment:

3.2.1 Procedure. Place a 9x reduced copy of a grid into each of the four channels. Place the full size master grid on the projection surface and check for best overall fit for each channel individually and all four channels combined. Repeat for 12x reduced grids.

3.3 Operational Test.

3.3.1 Procedure. Place a set of four (4) 12x reduced factor overlays in the projector. Superimpose all four using a different color for each. Note the ease, or lack of ease, with which this operation was performed. Repeat for 9x reduced overlays. After all four are superimposed remove the film chip holder and replace three (3) factor overlays with three other overlays, then register the three new overlay to the one which was left in place. Note how close the additional three overlays match the previously projected four. While the registered factor overlays are being projected place a 1:50,000 topographic map (of the same area) on the screen surface and note the match of the detail of the projected image to the detail on the map sheet.

3.4 Photographic Reproduction.

3.4.1 Procedure. With a set of four factor overlays superimposed and registered, turn filter wheel on each channel so that unfiltered light is projected. Place a piece of photographic film over the projection surface and place the rubber map on top of the film; make exposure of the projected image and process in normal manner.

After processing the film positive overlay, place completed factor map on the matching topographic map and note the accuracy of matching size and detail.

3.5 Ease of Operation.

3.5.1 During the above test make notes of problems which may indicate poor human engineering or flaws in the basic design of the TASS.

3.6 Maintenance.

Determine the need for preventive maintenance and high mortality parts. Make a list of spare parts that might be required to keep system operating.