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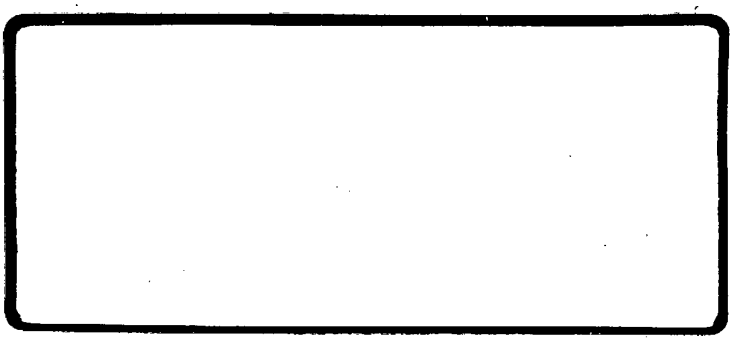

STAT

STATUS REPORT

for period

1 June through 30 June 1970

U.S. GOVERNMENT

[redacted] STAT

File No. 11038

[redacted] STAT

This document is presented as the Monthly Status Report under Contract to the U. S. Government, [redacted] STAT
The report period represented herein covers the period 1 June through 30 June 1970.

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APPENDICES

Packaging Details of the Stereocomparator Optical System — Appendix I

PROGRAM STATUS SUMMARY

Scheduled percentage of completion	95.6%
Actual percentage this date	89.5%

This report period is significant because the optics assemblies have been installed. The alignment of the optical system is in process, so far without significant problems. Check-out and response of the optics drives is underway. Satisfactory servo drive performance is being achieved.

Analysis is underway to provide information in order to eliminate the 20 hertz resonance in the stage drives.

The Image Analysis System has been checked out and found to be satisfactory and will be installed on completion of the optics drive checkout.

The substitution of real formats and units for bogus formats and units in the software is nearly complete. The sub-routines are being rewritten to take advantage of the additional 16K of computer core to be available shortly.

TASK 11

STAGE DRIVES

Scheduled percentage of completion	100%
Actual percentage this date	96%

Force displacement tests were performed on the right stage and left stage mechanical system in an effort to isolate the structural compliances causing the 20 hertz resonances mentioned in our last report.

The more significant compliances have been isolated and corrective measures are being analyzed. Mechanical stiffening as well as electronic compensation are under investigation.

TASKS 16, 17 & 18
VIEWING OPTICS, VIEWING ILLUMINATION
RETICLE PROJECTOR and ILLUMINATION

Scheduled percentage of completion	100%
Actual percentage this date	100%

The optical subassemblies have been received by [redacted] from the optical subcontractor. These assemblies were STAT received apparently in an undamaged condition, and all parts have been installed in the Stereocomparator. Optical alignment is in process. See Task 36.

An additional report on the design of the shipping containers is included with this report as Appendix I.

Additional information on the shipping containers and system was previously provided as Appendix II in the May, 1970, report.

TASK 23

OPTICS DRIVE ASSEMBLY

Scheduled percentage of completion	100%
Actual percentage this date	96%

With the arrival of the optics assemblies from the subcontractor, work on the optics drives has resumed.

It was found that an amplifier with a current output control instead of voltage output control greatly improved the mechanical performance of the system.

Another advantage of the current-output driver is that most of the system constants disappear. For example, a motor driven from a voltage source (zero output impedance) has the following system equation:

$$\frac{\theta_o}{E_i} = \frac{1/K_e}{s\left(\frac{LJ}{K_e K_t} s^2 + \frac{IR}{K_e K_t} s + 1\right)}$$

where

θ_o = output shaft angle

E_i = amplifier output voltage

K_e = back emf constant of the motor

K_t = torque factor of the motor

L = armature inductance

R = armature resistance

J = total system inertia

As can be seen, this system equation shows one integration plus a more or less damped quadratic term, with the damping roughly determined by the ratio R/J.

A current-driven motor (infinite source impedance) has the following equation:

$$\frac{\theta_o}{I} = \frac{K_t}{Js^2}$$

where I is the amplifier current and the other terms are as described previously. As can be seen, the system equation is independent of the back emf of the motor and the armature resistance and inductance. The presence of two simple integrations makes the basic tachometer (rate) loop cancel only one of the integrations, so that a Type II system results which has zero velocity - following error. Thus, the servo system characteristics are independent of speed, which produces good dynamic tracking.

This system is being exploited extensively in the optics drives, with very good effect.

The status of the optics drive loop compensation and phasing work is as follows:

A) The illumination zoom loop has been compensated, giving a 20 Hz rate loop bandwidth and a 4.5 Hz position loop bandwidth. A Type II system, with no velocity - following error.

B) Image rotators are complete, with a 50 Hz rate loop bandwidth and 4.5 Hz position bandwidth.

C) Anamorph rotators are complete, a 35 Hz rate loop bandwidth and a 2 Hz position loop bandwidth. This system

has a great deal of dry friction because of the slip rings and has a very large overhauling torque due to mechanical unbalance in the unit. It was found necessary to prevent the rate loop from saturating in order to maintain even rotational rates while slewing. This restricted the rotation rate to 1 turn in 4 seconds, but since there are two positions of the anamorph rotator which give the same stretch axis, the time required to reach alignment is two seconds maximum, since 180 degrees is the maximum required motion.

D) Reticle anamorph rotator compensation is complete. In order that the reticle alignment would not be disturbed, this system was not measured for bandwidth, but it greatly exceeds that of the main anamorph which it follows. Additionally, since it is a Type II system, there is no velocity - or position - following error.

E) Main zoom loop compensation has begun. Due to the great size of this system physically, a somewhat reduced rate loop bandwidth is contemplated in order to reduce wear. The usual 4.5 Hz position loop bandwidth is anticipated.

All of the above systems are overdamped in both rate and position loops, so that there will be no overshoot in either the computer-driven or manual operating modes. This produces a very pleasing optical effect.

Final phasing (wire-swapping) and necessary modifications to include the current output amplifiers are nearly complete for the above systems, and phasing of the main and follow-up systems has been implemented.

It is expected that during the next report period the remainder of the optical loop compensation will be completed, with the exception of the automatic brightness control loop, which cannot be started until final optical alignment is complete.

TASK 24

IMAGE ANALYSIS SYSTEM

Scheduled percentage of completion	100%
Actual percentage this date	98%

The [ ] Image Analysis System has been received [ ] The equipment was set up in the test fixture and tested. The video raster scan was reconstructed and determination of scanning axes made. Tests with the 1:1 test slides indicated good zero adjustment, with correlation readily obtained. The equipment did not, therefore, sustain any ill effects from shipment, and this system is ready for installation into the Stereocomparator upon completion of alignment of the optical systems.

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TASK 36

OVERALL ASSEMBLY

Scheduled percentage of completion	100%
Actual percentage this date	90%

During this report period the optical elements were uncrated and assembly to the Stereocomparator was started. The illumination system, lamphouse, variable diaphragm, and zoom condenser have been installed and aligned per instructions. The center optical bridge and both side optical bridges have been installed and alignment is proceeding.

TASK 43

COMPUTER PROGRAMMING

Scheduled percentage of completion	100%
Actual percentage this date	93%

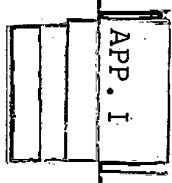
At the time specifications were written for subcontracting the writing of the computer program, it was not clear what formats and/or units would be used for teletype input of camera parameter information. Furthermore there was a possibility that some of this information might be classified. For the sake of definiteness and in order to avoid any possible need for classification, the subcontract specifications were written in terms of bogus formats and bogus units, with the intention that [redacted] (the prime contractor) would itself perform a modification to incorporate real formats and real units. The in-house modification has been under way for a number of months but intensively so during this report period, and is now nearly completed. STAT

Since the Stereocomparator hardware has not yet been assembled sufficiently to permit final debugging of the computer program, the subcontractor has not yet made formal delivery of the computer program [redacted] Nevertheless, the partially debugged tapes and listings of the program are available [redacted] STAT STAT

Such of these as apply to the teletype input were used in producing the in-house modified version, for real formats, etc. Although debugging these particular portions of the program should not, in principle, depend on availability of the Stereocomparator hardware, yet they were found to still contain a number of problems.

In undertaking to incorporate the real formats, etc. it was found that the bogus formats which were written into the specifications did not have the full variety of the real formats. This circumstance and the fact that there were still problems in the existing tapes prompted a decision to substantially rewrite some of the subroutines so as to provide more generality.

The in-house modification is being performed in two stages - the first of which has now been completed. In the first stage the various subroutines were rewritten, as required, to incorporate all necessary provisions for the full variety of the real formats - but to nevertheless still operate with the bogus formats. This allowed compiling and debugging the coding openly and provides a program which can be run openly with the hardware when it is completed. The second stage will be to actually incorporate the real formats into the revised coding. This is a relatively minor procedure and should be completed early in the next report period.



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Packaging Details of the Stereocomparator Optical System

This appendix is intended to supplement Appendix II of the report of 1 May to 31 May 1970, concerning the shipping of the optical system. It is hoped that these additional details will aid in the analysis of the design concept used in the packaging of this system.

All crates made [redacted] were of double con- STAT
struction with heavy gauge plastic "balloons" between the inner and outer cases, with the exception of the reticle branches. The reticle system had an additional third outer case, which was separated from the middle case by semi-hard rubber cubes in the corners and additional rubber mounts were also placed at suitable intervals between the middle and exterior cases. The construction of all interior cases consisted of a basic frame and sheeting technique. Frame members varied in size from 1" x 6" heavy supports to 1" x 2" material used as a frame for mounting the 3/8" plywood sheeting. The 1" x 6" members were felt covered when equipment rested on them. Also, each unit of the system was protected by a pre-sized plastic bag for protection from dust and dirt. The exteriors of all boxes, and the middle case of boxes 6 and 7, were constructed of wood that measured 8-1/4" x 5/8". Boxes 1, 6, and 7 had hinged tops and sides, while the other boxes only had hinged tops. The hinges enabled all the boxes to be reusable.

The balloons, in an unmounted state, measured 12" x 8" x 3" and were approximately three-fourths inflated. However, after mounting, they were approximately 5" thick and acted as if they were fully inflated. This was due to the method of mounting used [redacted] The balloons were stapled to the interior of the exterior case, (middle case on the reticle cases), in such a manner as to cause the 12" dimension to decrease to about 10.5" or 11". This had an "inflating" effect on the balloons and caused them to be very rigid. The plastic used for the balloons was 0.012 inches thick. STAT

The interior case of box #1, which contained the main optical bridge, measured L80" x W45" x H26.5" and its bottom rested on 34 balloons. The optical bridge is said by Sopelem to weigh 580Kg. The length by height dimensions had 12 balloons each, the width by height dimension also had 12 balloons each, but packed more densely than the other, and the top of case had 16 balloons. The exterior box measured L88" x W52" x H35".

The interior case of box #2, which contained the right illumination system, measured L60" x W27" x H26" and its bottom rested on 24 balloons. This unit is said to weigh 110Kg [redacted] The length by height dimensions had 12 balloons each, the width by height dimensions had 6 balloons each, and the top had 12 balloons. The exterior of the case measured L67" x W33" x H34". STAT

Box #3, which contained the left illumination system, had interior case dimensions of L60" x W27" x H26". The left illumination system is said to weigh 110Kg. Its interior case rested on 15 balloons. The length by height dimensions had 12 balloons each, the width by height dimensions had 6 balloons each, while the top had 12 balloons. The exterior dimensions of box #3 were L67" x W33" x H34".

The interior case of box #4, which contained the condensers, measured L22" x W17" x H18". Its bottom rested on 4 balloons, with both condensers said to weigh 50Kg [redacted] STAT The length by height dimensions had 4 balloons each, the width by height 2 balloons each, and the top had 3 balloons. The exterior of box #4 measured L30" x W24" x H26".

Box #5, which contained both variable diaphragms, had an interior case dimension of L32" x W16" x H18". These units were said to weigh 40Kg by [redacted] STAT and the interior case rested on 4 balloons. The length by height dimensions had 4 balloons each, the width by height had 2 balloons each, and the top had 4 balloons. The exterior case dimension was L40" x W23" x H26".

The interiors of boxes 6 and 7, which contained the reticle system, is said to weigh 454Kg, measured L59" x W36" x H45". The bottom rested on 20 balloons. The length by height dimensions had 14 balloons each, the width by height had 10 balloons

each, and the top had 14 balloons. The middle case measured L67" x W42" x H50" and was separated from the exterior case by the semi-hard rubber blocks. The exterior case measured L76" x W50" x H61".