Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

SUBJECT: BI-WEEKLY REPORT, Project 6345, November 27, 1950

To: J. W. Forrester

From: Project Whirlwind

1.0 SYSTEMS TEST

1.1 Whirlwind I System Test

(S. H. Dodd, R. R. Everett, N. H. Taylor, R. Read)

WWI has been operated several times with test problems read into electrostatic storage from paper tape. A number-conversion program using about 65 ES Registers was successfully operated several times. This program converts any binary number to any desired base up to 20 and displays the results on a display oscilloscope. Continuous operation for over an hour with several input numbers was obtained. Several other programs were operated successfully using electrostatic storage and tape input.

As a result of these test problems, several troubles were found and corrected.

1. In some digit columns, the negative rewrite immediately preceding a positive write operation resulted in a small positive spot. High velocity gun gates were readjusted.

2. A new method of setting the write minus signal plate gates resulted in more uniform negative writing.

3. Under certain conditions of operation, a decoupling choke was causing false triggering of the gun driver flip-flops. The choke was removed.

4. The effects of rewrite times on spot interaction were remeasured with new test programs designed to more closely simulate actual computer operation. Rewrite times were left at 4 and 3 microseconds.

1.1 Whirlwind I System Test (Continued)

5. Readout failures due to glass charging were found in digit 4. Digit 4 storage tube was replaced and much better test problem operation was immediately obtained.

(N. Daggett)

Test Control has been revised to make several additional functions available. It is now possible to select any time pulse of any order and to count n of these time pulses (where n may go as high as 2^{12}) in a counter. The counter end carry -- designated the selected pulse -- may be used to trigger an oscilloscope and/or to switch to pushbutton.

A second video switch panel has been added to test control to permit centralizing all important switches at one point. A simplified block schematic of Test Control has been prepared (SA-36264) which shows the functioning of essential switches and controls. Detailed layout of Test Control is shown in Block Schematic D-36038-1.

(H. F. Mercer)

Component Failures in WWI: The following failures of electrical components have been reported since November 10, 1950:

Component	No. of Failures	Hours of Operation	Reason for Failure
Crystals			
D-357	1	1382	Drift
	1	2886	Drift
	2	3400	1 Drift 1 Shorted
	1	3468	Low back resistance
D-358	4	1700-2000	Drift
	2	4041	
Tubes			
3E29	2	4309	1 Mechanical 1 High cut-off
6SN7	1	4817	Mechanical
	1	5090	Gassy
7AD7	1	60	Mechanical
	2	2925	Low I_b
7AK7	1	3525	High suppressor

1.2 **Five-Digit Multiplier**
(C. N. Paskauskas)

The multiplier recorded a series of errors at 1825, 19 November 1950 due to a Cambridge Electric Co. Power failure. No errors have been recorded since that date.

During the period of this report the following were replaced as a result of marginal checking:

2	clamp crystals
1	6AG7

Two 6AS6 gate tubes were removed for testing and returned to service.

2.0 CIRCUITS AND COMPONENTS

2.1 Circuits by System Number

400 Input-Output Element

(J. A. O'Brien)

Breadboards of some of the circuits to be used in the Input-Output switch have been constructed and testing will start on them immediately.

Additional circuits and layout sketches have been completed and will be turned over to the drafting room if results of the initial breadboard tests are satisfactory.

2.3 Driver Circuits

(T. Leary)

The investigation of the RDI Gate Generator has produced a slightly modified circuit which retains the improved rise time of Herb Ziegler's modification while giving the same gate length as the original circuit instead of a shorter gate. The new circuit has yet to be tried in the system.

2.5 Tubes and Components

(H. B. Frost)

During the last two weeks a large part of my time has been spent in arranging material and writing two papers to be presented at the Conference on Electron Tubes for Computers. As a part of this work analyses have been made of 7AD7 and D358 life in WWI. The results show that flip-flops are much harder on tubes and crystals than other applications. The rate of tube failure in flip-flops is about twice that in other circuits, and the rate of crystal failure is about ten times that in other circuits. The life of 7AD7 tubes in flip-flops apparently will average around 7-10 thousand hours. The life of D358 clamp crystals apparently will be about the same. In other applications both tubes and crystals will have much longer lives. This data is based on extrapolation, since only 5000 hour data is now available

2.5 Tubes and Components (continued)

from WWI; however, multiplier data shows that extrapolation of this type is apt to be pessimistic rather than optimistic.

As a result of the very poor quality of the last lot of 6AN5 tubes, there are very few of these tubes available for immediate experimental use, although ample quantities are on order. This should be borne in mind by engineers designing breadboards and other temporary apparatus. However, there appears to be no reason why designs now in progress for permanent equipment should be changed because of this temporary shortage.

(F. E. Irish)

The crystal diode life test has been in operation for 1000 hours. This has been, however, too short a period for any trends to be observed in the changes taking place in the static characteristics of these crystals.

A second type of change in back resistance has been observed in some crystals. The first type of change is the gradual drift up or down which occurs during the first minute after the back voltage has been applied to the crystal. This second type is an oscillatory change occuring not quite periodically at the rate of about one fluctuation per second. The nature of this fluctuation is not known, and it may be a noise voltage which appears in the static tests as a change in back resistance. It was noticed during the 1000 hour static test that the amplitude of this fluctuation was larger in the crystals which had been "on the shelf" than in those which had been in the clamping circuit simulator.

3.0 STORAGE TUBES

3.1 Tube Construction

(P. Youtz)

Two storage tubes were processed successfully this period. RT-190 was designed to minimize the drift of the high-velocity beam resulting from charged glass surfaces. All of the glass was dagged except for a quarter-inch window between the A_2 and A_3 dags. There is a metal shield over the separation between A_2 and A_3 to prevent the glass window from charging. The holding gun has a 1 1/2" diameter metal A_2' cylinder. Another similar storage tube, RT-191-1, was constructed and will be put on the exhaust systems early next week.

The storage tube, ST-300, for WWI was processed this period. This tube is identical with the earlier storage tubes in the 100 series for WWI except the mosaics were lined up with the deflection plates and the mica spacer was redesigned to give more uniform spacing between the screen and the mosaic surface. A light fixture was used in this tube to align the high-velocity gun. Also, this tube contained a mica surface cleaned by a new method. We had re-examined all our cleaning, handling and processing procedures to find possible sources of contamination which might cause surface leakage. This mica surface was cleaned in a hot chromic acid bath followed with several hot distilled water baths and one steam bath.

Satisfactory mica surfaces have not only been very difficult to procure but they have been difficult to process as storage surfaces. Some pieces of mica buckle in the storage assembly and other pieces of mica have developed air inclusions during processing. Therefore, we have been studying other possible dielectrics for storage surfaces besides mica. Investigations a year ago showed that a Vycor storage surface was not only very fragile but had undesirable operating characteristics. Toward the end of getting a uniform dielectric storage surface with an attached signal plate, we have attempted to evaporate dielectric materials directly on metal backing plates. We have evaporated films of silicon monoxide on stainless steel and oxidized the material to get silicon dioxide. This method has not produced uniform dielectric materials of the desired thickness of .005 inches. Also, we did not get the expected volume resistivity. It is believed there was some reaction between the tantalum evaporation cup and the silicon monoxide. This will be discussed next week with Professor Louis Harris of the MIT Chemistry Department.

3.1 Tube Construction (continued)

We also evaporated calcium floride on stainless steel plates. The first attempt was made with a tantalum cup and the second with a carbon cup. Neither method provided a dielectric with the expected volume resistivity. It is believed all of these materials have been reacting with the evaporation cup.

Another approach to the problem has been to settle a uniform layer of the dielectric material on a metal backing plate and sinter it to the backing plate. These experiments have just been started and will continue during the next bi-weekly period.

(R. Shaw)

A series of experimental tubes is being made to determine the feasibility of cementing metal anode cylinders to glass or ceramic support rods. These tubes consist of a stainless steel cylinder, representing an anode of a proposed electron gun, mounted in a 2" O.D. envelope. Support rods are cemented with "Insalute" into notches in the flanges which are provided at both ends of the cylinder. Each tube is evacuated and subjected to the usual storage-tube bakeout. Up to the present time, Pyrex rod and thin-walled steatite tubing have been tried, but both fractured in the apparently unstressed part beyond the flanges. A third tube, using heavier steatite tubing, will be made this week.

A new form has been made for the storage tube construction schedule. This incorporates suggestions from several members of the storage tube group and from A. M. Falcione. Future schedules will be issued on this form.

3.2 Test

(A. Stein)

Pre-tests were performed on the television demonstration unit.

RT-190 was pretested and passed.
All video cabling on the TV Demonstration unit was traced in order to draw up a new block diagram of this test set-up.

Four Gate & Delay units were modified by replacing R 13 and R15; originally 2-22,000 ohm, 2 watt resistors by 1-10,000 ohm, 8 watt resistor. The purpose of this change is to suppress free-running. The units were tested and found to operate satisfactorily.

3.2 Test (continued)

The wiring on the tube mount on the TV demonstration un was changed in order to accommodate the changed voltages on A_2' and A_3.

(C. L. Corderman, H. J. Platt)

The STRT has been modified to allow spot interaction tests which simulate the selective write mode of operation of storage tubes. This was done by alternating the polarity of writing around a center spot where formerly only writing of the polarity opposite that of center spot was possible.

Present checking of r-f and video aligned mounts consists of determining suitable signal plate and high velocity gun gate amplitudes and the holding gun time necessary for giving satisfactory operation in the spot interaction test.

Until tubes are pretested with the new voltages on A_2' and A_3, the STRT checkout also insures that holding beam coverage is complete with $V_{A_2'} = 45$ volts and $V_{A_3} = 165$ volts.

Of three tubes checked to date, ST189 has been passed as satisfactory while the other two were temporarily held up; ST132 for incomplete holding beam coverage with $V_{A_2'}$ less than 100 volts, and ST138 because of a crescent-shaped block which switched positive with V_{A_3} greater than 125 volts.

The new increment supply has been checked out and installed. This replaces 3 type P1 supplies previously used which gave a rather coarse adjustment and a slight 60 cycle ripple.

(A. R. Tanguay)

Investigation of the equilibrium HG current, mentioned in the last bi-weekly, has been discontinued until a workable pulsed voltage measuring device is built.

The slide-back voltmeter built two weeks ago proved unsatisfactory because of a low frequency d-c level shift in the output circuit. It suffered further from the disadvantage of providing no true null for accurate observation of the balance point.

W. J. Nolan suggested a circuit employing suppressor grid controlled current division between plate and screen.

3.2 Test (continued)

The plate and screen grid currents flow through a pulse transformer in such a way that no output results when the suppressor potential is a few volts negative to the cathode. This permits direct reading of the suppressor voltage, plus a constant correction, by measuring the cathode potential with respect to a common ground. By this method the potential of any voltage wave at any point may be measured by employing a short "position selecting" pulse to turn on the normally cut-off tube.

A breadboard assembly of the instrument proved satisfactory; a permanent model will soon be constructed.

(M. F. Mann)

An operation manual for the TV Demonstrator has been started.

4.0 INPUT-OUTPUT EQUIPMENT

4.1 Eastman Kodak Film Units

(J. A. O'Brien)

We have received word from Eastman Kodak Co. that they have finished a model of the new reading light source, mentioned in the bi-weekly report of 29 September, and they are sending it to us for testing on our unit with the computer.

(D. Hageman)

Satisfactory films of relatively high exposure density and bearing the larger spot size were prepared following location of the difficulties alluded to in the previous bi-weekly report. That is to say, these films are satisfactory insofar as examination by means of the Recordak viewer is concerned. The density of exposure involved is the highest that can be obtained without driving the control grid of the CRT positive during intensification and, as such, is less than that of the films which were successfully "read" some time ago, but greater than that customarily used prior to the recent visit by Eastman representatives.

As soon as computer time becomes available, recordings consisting of the so-called "checker board" pattern (an approximation to the type of pattern most difficult to read), as well as certain others, will be prepared for subsequent reading tests. At the conclusion of these reading tests it may be possible to finally assess the usefulness of these devices.

4.2 Display

(R. E. Hunt)

Work continues on the 16" display unit. The concepts outlined in the last bi-weekly report remain unchanged except that it now seems to be preferable to build a counter height unit. It turned out to be nearly impossible to observe a desk height unit comfortably without excessive parallax.

A full size mock-up of the proposed unit is presently being constructed, and will be available for comment in a few days.

4.3 Typewriter and Tape-Punching Equipment

(J. S. Hanson)

Adjustment of circuit constants in the R-C damping circuits associated with various relays in the tape output equipment did not result in sufficient speedup of the overall system to permit the tape reader mechanism to operate continuously. Performance tests are nearing completion, and timing data will have to be analyzed in order to determine where the major portion of the delay is occurring.

4.4 Input-Output Planning

(C. W. Watt)

Layout of the new In-Out Register was begun; and the schematic was completed. A preliminary schedule for construction of the registers was made, and production quantities of the critical items were ordered.

(T. L. Rocss)

Magnetic Tape Equipment: A recording circuit has been designed for magnetic tape which employs a d-c erase. Initial tests seem to indicate that this circuit will be satisfactory for producing pulses of current (about 25 ma) in the recording head over a possible range of 10 to 100 microseconds. Two channels have been constructed (breadboard-style) for use with tape driving equipment to be delivered by Raytheon.

5.0 INSTALLATION AND POWER

5.2 Power Supplies and Control
(J. J. Cano)

D.C Plate Supply Alternator: The motor and Relay Panel has been installed and connected to the system. The remaining two panels, the Regulator and its Power Supply, should be installed within the next two or three Saturdays.

5.3 Video Cabling
(T. Leary)

A backlog of paper work caused by the removal or rearranging of a number of cables has accumulated and must be dealt with. There is one new cable to be built.

6.0 BLOCK DIAGRAMS

(R. P. Mayer)

Memorandum M-1085, "Orders sl and sr; Provisions for Selective Roundoff", describes the functioning of the sl (800 + n) and sr (800 + n) orders for preventing the round-off and clearing of BR that normally occurs when sl n or sr n is ordered. The unused FF in AC15 carry will be used for "Shift Roundoff Control (SRC)", and plans are being prepared for the actual connections on the panel.

An attempt is being made to provide an up-to-date set of block diagrams as soon as possible. After that has been accomplished, the plan is to re-draw several block diagrams in a more integrated form similar to the In-Out and the Electrostatic Storage Block Diagrams.

(J. M. Salzer)

The present state of input-output was reviewed with a view of designing the in-out orders. An attempt to group the various in-out units by a broad classification has failed, and it appears necessary to pay separate attention to each type of equipment in order to insure the adequacy of block-diagram and timing designs.

7.0 CHECKING METHODS

7.1 Test Problems

(G. Cooper)

E-359 has been published. Several ES Test Programs have been accumulated since its publication. These will be covered in a future note.

Considerable work has been done towards obtaining a set of test sequences for checking the operation of the entire arithmetic element. It is expected that this set will be completed during the early part of the next period.

8.0 MATHEMATICS

(C. W. Adams)

The preparation, duplication, and filing of punched paper tape and associated manuscripts is being organized into a routine procedure. Every new tape is given a number and every copy of a given tape is assigned a copy number. Master and duplicate files of both tapes and manuscript will be maintained, along with an index file. M-1130 will describe the procedure in detail.

(J. M. Frankovich)

Work has continued on the eigenvalue problem previously described. A potential function has been tabulated for use with the continued fraction program and a tape is being prepared. A program using the Runge-Kutta method has been prepared, but it leaves no room for a tabulated function in the present ES storage. An integral equation method of solving the problem has also been investigated, and though a lengthy program would apparently be required I shall spend some time in the next bi-weekly period preparing a program for this method because of its importance with respect to the solution of the general problem.

(J. D. Porter)

The subroutine adaptation program discussed in M-1125 has been revised and the procedure outlined there is being rewritten accordingly.

I have obtained a copy of the galley proofs of Professor S. Bergman's forthcoming book "The Kernal Function and Conformal Mapping". This book (Chap. XI) describes the use of kernel functions and closed systems of orthogonal functions in the solution of boundary value problems in the theory of partial differential equations. It provides a numerical method which is suitable for use on a large-scale computer such as ours.

(F. Helwig)

The following checking subroutines have been written:

(1) Print the contents of register m immediately before executing the order in register m. The following characters are punched on tape during each application of the subroutine:

8.0 MATHEMATICS (continued)

(a) Carriage return
(b) WWI decimal code for the order in register m.
(c) Space
(d) Decimal address of the order in register m.

(2) Execute the main program order by order. Print a code symbol before each order is executed unless the order is an sp or a cp order. In this case print a k or a c respectively and follow this by a carriage return if a change of control occurs.

(3) Execute the main program order by order. Perform checking subroutine (1) before executing each order in the main program and follow this by a carriage return.

Simplified versions of (2) and (3) have been written which can be used if the main program does not contain any sa orders.

9.0 FACILITIES AND CENTRAL SERVICES

9.1 Publications

(J. N. Ulman, Jr.)

The following material has been received in the library, Room 217, and is available to 6345 personnel.

6345 Reports

No.	Title	No. of Pages	Date	Author
R-193	Selected Descriptive Material Whirlwind I Computer. Vol. 1: General. Vol. 2: Introduction to Coding		11-10-50	C. W. Adams, ed
E-359	ES Test Programs	15	9-25-50	G. Cooper
E-387	Interim Equipment and Techniques for Input, Output, and Control for WWI. FOR INTERNAL DISTRIBUTION ONLY.	31	10-24-50	C. W. Adams
E-389	Construction of a WWI Storage Assembly	4	10-31-50	J. Palermo
M-1085	Orders sl and sr: Provisions for Selective Round Off	3	11-14-50	R. P. Mayer
M-1125	Bi-Weekly Report, Project 6345, November 10, 1950	16	11-10-50	
M-1128	A Proposal for Power and Video Cabling in the New Control Room	4	11-15-50	C. W. Watt
M-1129	A Direct-Coupled Amplifier for Magnetically Deflecting an Oscillograph Tube: M. S. Thesis Proposal	9	11-20-50	R. L. Best

Library Files

	Proceedings of the IRE: October, November, 1950	I. R. E.
.004	European Scientific Notes: 15 October, 1 November, 1950	ONR/London
47	Technical Information Pilot: October 16, 1950	(ONR/Library of (Congress
51	Tracerlog: November, 1950	Tracerlab
178	Mathematical Tables and Other Aids to Computation. Complete Files 1943, 1944, 1945	(National Researc (Council
180	Document Office Bulletin: November 17, 1950	RIE/MIT
271	Investigations for Design of Digital Calculating Machinery Progress Report No. 13, covering period 10 August to 10 November, 1950	(Computation Lab. (Harvard Univ.
559	Technical News Bulletin: November, 1950	Ntl. Bur. Stds.
597	Reports on Research: November, 1950	MIT
1017	Electrostatic Storage Tube: Reprint paper presented at AIEE meeting April 26-28, 1950	(S. H. Dodd (H. Klemperer (P. Youtz
1018	Statistical Analysis Montclair Public Library - 1943	(Montclair Public (Library
1019	An Introduction to the UNIVAC System. 1950	(Eckert-Mauchly (Computer Corp.

9.1 Publications (Continued)

Library Files (Continued)

No.	Title	Author
1020	On the Accumulation of Errors in Processes of Integration & Note on Rounding-Off Errors. June, 1950	H. A. Rademacher, G. E. Forsythe, Ntl. Bur. Stds.
1021	A Sampling Method for Determining the Lowest Eigenvalue and the Principle Eigenfunction of Schrödinger's Equation. RP 2102, May, 1950	M. D. Donsker, M. Kac, Ntl. Bur. Stds.
1022	Note on the Runge-Kutta Method. RP 2101, May, 1950	W. E. Milne, Ntl. Bur. Stds.
1023	Acceptance Sampling by Variables, with Special Reference to the Case in Which Quality is Measured by Average of Dispersion. RP 1827, September, 1947	J. H. Curtiss, Ntl. Bur. Stds.
1024	On the Precision of a Certain Procedure of Numerical Integration. RP 1950, January, 1949	H. D. Huskey, D. R. Hartree, Ntl. Bur. Stds.
1025	Solution of the Telegrapher's Equation with Boundary Conditions on Only One Characteristic. RP 2059, January, 1950	G. E. Forsythe, Ntl. Bur. Stds.
1026	The Remainder in Linear Methods of Approximation. RP 2041, November, 1949	W. E. Milne, Ntl. Bur. Stds.
1027	A Note on the Numerical Integration of Differential Equations. RP 2046, December, 1949	W. E. Milne, Ntl. Bur. Stds.
1028	A Problem on Arc Tangent Relations. October, 1949	J. Todd, Ntl. Bur. Stds.
1029	An Elementary Introduction to the Calculus of Variations	M. R. Hestenes, Ntl. Bur. Stds.
1031	Generation and Testing of Random Digits at the National Bureau of Standards, Los Angeles. Part of a Symposium on the Monte Carlo Method. 30 June, 1949	G. E. Forsythe, Ntl. Bur. Stds.
1032	Sampling Methods Applied to Differential and Difference Equations with Special Reference to Equations of the Elliptic Type	J. H. Curtiss, Ntl. Bur. Stds.

Books

Finite Differences and Difference Equations, 1949	T. Fort
Electrical Engineers Handbook, Fourth Edition: Communications, Electronics, 1950	H. Pender, K. McIlwain

9.2 Standards, Purchasing and Stock

(H. B. Morley)

STANDARDS

Recent MIL (JAN) Standards issued:

MIL - C-239B - Military Specification Crystal Unit, Quartz (CR-5/U)
JAN-C-92 - Capacitors, Air Dielectric, Variable (Trimmer Capacitors)
ASESA List No. 100 - Armed Services Index of Electro Standards

PROCUREMENT AND STOCK

Arrangements have been made to procure liquid nitrogen from the MIT Cyrogenic Lab. as an alternate supplier. They state that they have improved their facilities so that breakdowns and consequential delays in delivery of the item will not be likely to occur as in the past.

Work load of this department continues to increase. Total expenditure for materials will probably be twice as great as the previous month. Orders are being processed for critical components for the production schedule of input-output items.

All personnel using test equipment taken from the stock room are again requested to report any damage or defects in these units to Pagliese so that necessary repairs or calibrations shall be made.

9.3 Construction

(R. A. Osborne)

Production Report

The following items have been completed and inspected since November 10, 1950:

1 Meter and Relay Panel for D-C Plate Alternator
1 Video Switching Panel
6 Lamicoid Nameplates "Non-Standard Power Connector"

9.3 Construction (continued)

Modifications to two Western Electric Type CW-20-AAE Power Supplies.

1 ESD Output Model #2 Breadboard

1 D-C FF and GT Breadboard

9.4 Drafting

(A. M. Falcione)

Input-Output Items

1. Temporary drawings for the In-Out Register will be ready in about a week. This includes the circuit schematic and preliminary layout.

2. Drawings for the In-Out Switch, Bus Driver Panel will be completed at the same time.

3. Drawings for the In-Out Switch, Switch Panel (formerly called the Flip Flop Panel) are being held up pending additional changes on the prototype panel now being tested by J. A. O'Brien.

Work Load

The work load at the present time is quite heavy. Indications are that the new units to be built for the In-Out system plus our regular work tax our capacities to the limit.

10.0 GENERAL

(H. Fahnestock)

New Non-Staff

Cosimo J. Favaloro of Boston is a new student technician working in the storage tube group. He is a Northeastern University engineering student.

Non-Staff Terminations

Elis A. Guditz