Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

SUBJECT: BIWEEKLY REPORT, April 24, 1953

To: Jay W. Forrester

From: Laboratory Staff

1.0 SYSTEM OPERATION

1.1 Whirlwind I System

1.11 Operation (F. J. Eramo)

The following is an estimate by the computer operators of usable percentage of assigned operation time and the number of computer errors for the period 10 - 23 April 1953:

Number of assigned hours	98
Usable percentage of assigned time	83
Usable percentage of assigned time since March, 1951	85
Number of transient errors	57
Number of steady-state errors	4
Number of intermittent errors	6

(S. H. Dodd)

The new marginal-checking system has been installed and tested in the computer and is operating very satisfactorily. This new system features gas-tube counters instead of the stepping switches, which allows a number to be inserted directly into the counter controlling the cross bar switch, thus avoiding dialing.

In addition, provision is made so that the computer can read a number into this counter and thus select marginal-checking lines as specified in a computer program. This system is fail-safe in all its aspects and promises much higher reliability of operation than the old marginal-checking system.

The Ferranti photoelectric tape reader has not been delivered due to loss of drive motors in the recent floods in England. The delivery date is therefore, at the moment, entirely undetermined.

1.11 Operation (continued)

(C. L. Corderman and D. M. Fisher)

The operational status of Bank A remains essentially unchanged from the previous biweekly report. Very few tubes have been replaced in this bank because of low margins. Attention has been concentrated instead on replacing those tubes which seem to switch positive most consistently. It is now felt that the positive switching is definitely associated with the storage tubes and not the circuits.

A new comprehensive test program for ES has been written. Identical programs are first read into each bank of storage and then transferred to the magnetic drum. By setting appropriate orders in flip-flop storage the programs may be read into either bank of storage which will then allow testing of the other bank. Before this can be used, however, the marginal-checking lines connected to the parity digits will have to be changed. At present, the parity digit on one bank has marginal-checking lines in common with the opposite bank of 16 tubes. In order that parity check may still be left in during testing with no danger of destroying the program which is in ES, the parity digits could be placed on six new marginal-checking lines. A possible alternative would be a set of switches so that the parity digits could be operated in common with either bank of ES.

(N. L. Daggett)

Thanks to the excellent cooperation of drafting room, shops, and various systems people involved, the Mod II marginal-checking system has been installed on schedule and is working very satisfactorily. The programmed marginal-checking mode will be incorporated in routine daily checking as soon as the necessary programs have been written.

Some twenty hours of computer time were lost this week tracking down an intermittent difficulty encountered in a program by Combelic. The symptoms were different results each time the program was rerun, even though identical initial conditions were used. After Combelic had rewritten the program to make it self checking at major points, several very poor margins were discovered. These were on lines which, for any existing check programs, gave good margins. Since the complicated nature of the program made it extremely difficult to determine on what order the errors were occurring, it was localized by rewiring one of the marginal-checking circuits to vary successively smaller groups of circuits until eventually the line varied one gate tube on an accumulator panel. Observation of the pulse output of this gate showed rather odd prf sensitivity at certain points in the program. Replacement of the cathode follower driving this gate returned the output and the program to normal operation.

1.11 Operation (continued)

(S. E. Desjardins)

A block diagram has been drawn for a proposed "Double Parity Check" system. This system will allow a second ES read to occur after a parity alarm. If the second ES read is successful, the program will continue. If a second parity alarm occurs, the computer will either stop or erase storage and provide a start-over pulse, depending on the mode of operation selected.

(L. L. Holmes and J. H. Hughes)

The new WWI order ab was installed on Saturday, April 11. The order has been checked out and is functioning as expected.

(L. L. Holmes)

Eight panels known as the IOR Counter have been designed, constructed, and tested and will be installed in WWI April 25. This counter will be associated with digits 0-7 of the IOR and will provide a means to count down (subtract) when using MITE.

1.12 Component Failures in WWI (L. O. Leighton)

The following failures of electrical components have been reported since April 10, 1953:

Components	No. of Failures	Hours of Operation	Reasons for Failure
Capacitors			
Variable, 4-30 mmfd	1	11000 - 12000	Open
Crystals			
D-357	2	16000 - 17000	Excessive drift and high forward resistance
1N34A	1	7000 - 8000	Low R_b
1N38A	1	4000 - 5000	Drift to low R_b
	1	7000 - 8000	Low R_b
Potentiometers			
10-K 2-watt carbon	1	12000 - 13000	Noisy
2500-ohm 2-watt	1	7000 - 8000	Noisy
	1	11000 - 12000	Noisy

1.12 Component Failures in WWI (continued)

Components	No. of Failures	Hours of Operation	Reasons for Failure
Resistors			
Carbon 220 ohm 1 watt ±5%	1	7000 - 8000	Above tolerance
	2	8000 - 9000	Overheated
	1	11000 - 12000	Below tolerance
	1	12000 - 13000	Above tolerance
Deposited Carbon 125K 1/2 watt ±1%	1	1000 - 2000	Above tolerance
Deposited Carbon 5000 ohm 1 watt ±1%	1	7000 - 8000	Above tolerance
Tubes			
7AD7	2	0 - 1000	Short
	1	5000 - 6000	Low I_b
	2	9000 - 10000	1 short; 1 leakage
	2	10000 - 11000	Low I_b
	3	11000 - 12000	2 low I_b; 1 grid emission
	2	12000 - 13000	Low I_b
	16	16000 - 17000	6 short; 7 low I_b; 3 leakage
	5	17000 - 18000	2 low I_b; 2 short; 1 broken envelope
7AK7	3	16000 - 17000	2 short; 1 low I_b
3E29	1	11000 - 12000	Short
	1	16000 - 17000	Low I_b
6AL5	2	5000 - 6000	Low I_b
	2	9000 - 10000	Low I_b
G1L5	1	0 - 1000	Short
6L6	1	16000 - 17000	Low I_b
6SN7	1	15000 - 16000	Low I_b
6AS7G	2	13000 - 14000	1 short; 1 bad heater
SR-1407	1	4000 - 5000	Short
5U4G	1	5000 - 6000	Short
6AG7	1	9000 - 10000	Low I_b
6Y6	2	1000 - 2000	Short

1.13 Storage-Tube Failures in WWI (L. O. Leighton)

The following storage-tube replacements were reported during this bi-weekly period:

ST-543-3 was rejected after 192 hours of operation because of failure to hold a positive array.

ST-700-C was rejected after 2713 hours of operation because of low margins.

ST-806 was rejected after 164 hours of operation because of internal breakdown and failure to hold a positive array.

1.14 Storage-Tube Complement in WWI (L. O. Leighton)

Following is the storage-tube complement as of 2400 April 23, 1953:

Digit	STM No.	Tubes	Hours of Installation	Hours of Operation
0 B	38	ST-619-C-1	10069	3699
1 B	12	ST-711-C	11989	1779
2 B	31	ST-807	13501	267
3 B	10	ST-601	8524	5244
4 B	33	RT-380	13516	252
5 B	41	ST-745	12982	786
6 B	3	ST-751	13170	598
7 B	26	ST-540	7937	5831
8 B	21	ST-739	12729	1039
9 B	42	ST-720-C	12937	831
10 B	2	RT-382	13629	139
11 B	25	ST-753-1	13129	639
12 B	28	ST-747	13261	507
13 B	9	ST-803	13411	357
14 B	24	ST-624-C-1	10507	3261
15 B	16	RT-383	13629	139
16 B	11	ST-716-C-1	11702	2066

1.14 Storage-Tube Complement in WWI (continued)

Digit	STM No.	Tubes	Hours of Installation	Hours of Operation
0 A	43	ST-722-C	13130	638
1 A	20	ST-752-1	13170	598
2 A	4	ST-754-1	13170	598
3 A	23	ST-802	13411	357
4 A	32	ST-808	13516	252
5 A	40	ST-525	13389	379
6 A	34	ST-710-C-1	12889	879
7 A	35	ST-800	13340	428
8 A	45	ST-729-1	12600	1168
9 A	44	ST-742	12640	1128
10 A	30	ST-801	13363	405
11 A	36	ST-744-1	12822	946
12 A	8	ST-746	12982	786
13 A	14	RT-381	13581	187
14 A	5	ST-614	13235	533
15 A	22	ST-805	13457	311
16 A	27	ST-613	9046	4722

ES Clock hours as of 2400 April 23, 1953. 13768
Average life of tubes in service in Bank B. 1614
Average life of tubes in service in Bank A. 842
Average life of last five rejected tubes. 3132

2.0 CIRCUITS AND COMPONENTS

2.1 Circuits by System Number

2.13 Arithmetic Element (Callahan, Aronson, Thompson, Heineck)

The past biweekly period was spent in making a rather detailed study of time-pulse distributors. Equipment counts were made of existing and new distributors. The results will be published in an M-note.

2.14 Input-Output (R.H. Gould)

In-Out Control has been simplified by the removal of one synchronizer. Operations external to IOC remain the same. Further simplifying modifications will be made next week affecting only the internal operation of IOC.

Additions to IOC will be made April 25 for control of MITE buffer storage which should be in operation next week.

(R.H. Gerhardt)

The study of the input-output needs for WWII is continuing. A flow diagram showing the necessary flow of pulses and a block diagram have been made. An M-note is being written describing the functions of this interlock and the progress to date.

M.I.T.E. (R. Paddock and A. Werlin)

Buffer storage for modified MITE has been completed; cables for tying five registers of buffer storage to modified MITE and to WWI have been received and installed. Preliminary testing of buffer storage is partly complete and shows no faults so far; testing with WWI will start next week.

Tests on the two standard MITE's will begin during the next biweekly period.

Diagrams have been drawn and a C.R. issued for a panel to switch the standard MITE to any demodulator and to any video filter. A wiringg diagram is now being drawn for a dummy MITE to facilitate the use of video filters with this switching system.

2.14 Input-Output (continued)

M.I.T.E. (Sandy, Dintenfass, Ginsburg)

The MITE Matrix, WWI, and Indicator Light Matrix, WWI, were statically checked and are being installed.

The first display-gate circuit panel, WWI, was statically tested for the second time and is being installed.

The first intervention-register panel, WWI, is being statically tested for the second time now. We find that about one-half of the crystals have to be changed because of low back resistance or drifting.

2.2 Vacuum Tubes and Crystals

2.21 Vacuum Tubes (H.B. Frost)

A modification has been made in the transconductance bridge for interface measurement. The 50-ohm carbon potentiometer in the complementary circuit has been replaced by two decade resistors, giving 1/2-ohm steps. This has resulted in a much more satisfactory circuit, with much less noise, and better repeatability and accuracy. In addition, the switching between alternate complementary networks has been changed to reduce the residual inductance in the circuit.

Modifications have been made in the old pulser used for cathode interface measurements. These modifications have resulted in a cleaner pulse, with 0.02 microseconds rise time. This pulser is being studied for possible use as a tool for scope lineup.

Tests have been made on a lot of 5899 tubes which have been on life test for about 1500 hours, cut off. This tube is being tested for cathode studies as no application is presently planned. Very good stability of cathodes, with no interface resistance, was found on retest. A 12BY7 which has run for 1500 hours cut off also was retested. No change in transconductance was found, nor was there any slump. However, considerable grid emission was observed on test.

On April 20 and 21, there were meetings of the interface task force of ASTM committee B4-VIIIA and JETEC 5.5. Useful discussions were held with various engineers at these meetings. In particular, a lot of new 6145 tubes, with a modified screen grid, have been received for test. Initial shrinkage was lower than on previous lots, but the low figure could have been caused by the small lot size. These tubes will be life tested as soon as possible.

2.21 Vacuum Tubes (continued)

Specifications on a special neon indicator tube developed for Remington-Rand have been received. Anyone interested is invited to see them.

(S. Twicken)

The tube test specifications have been reviewed; some changes have been made in incoming test specs and extensive additions made to retest specs. The new specs will shortly be circulated to interested people for comments before actual incorporation into practice and inclusion in the Standards Book.

The 6145 life test has now run 1700 hours. For the past 500 hours, the "off" tubes have been running with a duty factor of about 0.05 and the "on" tubes about 0.95. The increase in duty factor from zero to 0.05 (a much more practical value) has cleared up a great deal of the gas recorded on the cut-off tubes at 1200 hours. The "off" tubes average about 1.5-ma higher plate current than the "on" tubes with the average "on" tube current about 2.5-ma lower than after the 100-hour stabilization period. The life test is continuing with new lots being added.

Visits have been made to the Chatham Electronics Corp., Newark, and McLeod and Hanopol, Charlestown, to discuss construction of the new tube tester. Bids are expected from both this week. A delivery date of July 15 appears to be tight but possible.

2.22 Transistors

Hole Storage (N.T. Jones)

A number of transistors were measured for storage effects in the newly adopted standard circuit. A storage coefficient will be determined from these measurements and correlation with circuit results will be made. Some correlation has been done indirectly, but not on an organized basis.

Data on storage in collector diodes of RCA TA 165 and 164 transistors has been taken and is now being plotted. A sample of Western Electric junction diodes is being received from Bradbury of AFCRC on a loan basis. Transistor Products bonded diodes are scheduled for observation in the very near future.

2.22 Transistors (continued)

Measurements (N.T. Jones)

Only one new transistor was received this period. It was a CBS-Hytron PT-2S. It completes the order of ten of these units.

After the discovery that several old units have failed, D. Smith has begun remeasuring all transistors on hand. Many failures have occurred. The main reason for this is that transistors have been put back in the cabinet after they have changed, have been changed, or have burned out. This is partially under control at present.

(D.J. Eckl)

A diode-characteristic plotter, originally breadboarded by I. Aronson, is now being rebuilt as a standard measurement device. This unit will make possible inspection of the characteristics of the individual diodes in each transistor.

Sergio Valdez is now working on the problem of producing equipment to display α as a function of I_e. An α vs. frequency plotter has also been considered.

A standard N-curve sweeper to replace the breadboard model now in existence will also be built.

Life Tests (N.T. Jones)

Wiring of the d-c portions of the expanded life tests is being done by R. Burke and F. DaCosta. Accessory equipment and power supplies remain the major immediate problems.

The old life tests were terminated on April 13. D. Smith is now processing data.

(D.J. Eckl)

Panels are under construction for the new life tests. The first tests to be activated will be shelf, cut-off, and various d-c dissipation tests.

Transistor Accumulator (D.J. Eckl)

Total operating time is now 4270 hours. Marginal checking is still being installed on the vacuum-tube gates in the system.

2.22 Transistors (continued)

Transistor Core Driver (S. Oken)

The tests on the single core mentioned in the last bi-weekly have given good results. A "one" has been written into and read out of a core at a 3-kc prf continuously for the last week without any harmful effects on the transistors.

A block diagram of a test setup for a transistor-driven 4 x 4 memory plane has been completed. It is almost the same as that used on one plane of the MTC memory. After it is built and working properly with standard test equipment, I will try to replace all this equipment with equivalent transistor circuitry. Thus the goal will be to have a memory composed only of cores; transistors, and crystal diodes.

Transistor Flip-Flop (E. Cohler)

The transistor flip-flop is undergoing tests as to the number of transistors of different types that will work under typical conditions. In addition, the write up of the principles and problems discovered in the study is approaching an end, and the note will be appearing soon.

2.3 Ferromagnetic and Ferroelectric Materials

2.31 Magnetic-Core Materials (D. R. Brown)

No additional cores for MTC planes have been received during the past biweekly period, but cores are available at General Ceramics and will be sent as soon as preliminary tests have been completed there.

The General Ceramics part No. F-291 is now obsolete. It is replaced by part No. F-383, same as F-291 but without chamfer.

A new size has been requested from General Ceramics: OD, 0.080 in.; ID, 0.050 in.; and thicknesses of 0.015 in. to 0.030 in. This is the most promising size for the prototype. Thinner F-340 and F-383 cores have been requested.

A core tester has been set up at IBM in Jack Goetz's group.

The first IBM core-handling mechanism has been assembled and is being refined.

Production Tester for MTC Cores (J. Schallerer)

Work is continuing on the cores that have high outputs. An attempt is being made to correlate core dimensions and core output. The major factor being investigated is core thickness.

Data must be rerun on the F-340 cores since it is felt the current calibrator was not operating properly at the time of the initial tests.

Temperature Tests on MTC Cores (J. D. Childress)

The temperature tests started in the previous period are being continued. Indications (not conclusions) are as follows:

1. At I_m = 900 ma, the cores operate satisfactorily at temperatures up to 50° C.
2. At reduced currents, cores may operate above 50° C with some decrease in signal-to-noise ratio.

New Materials (B. Smulowicz)

A pulse test has been performed on XF-127, a new RCA Victor body with a very short switching time.

A technician is being trained to operate the pulse-testing equipment in order to facilitate a rapid survey of specimens characterized by a high squareness ratio.

2.31 Magnetic-Core Materials (continued)

Ferrite-Core Pulse Tests (J. R. Freeman)

Ferrite-core pulse-testing equipment using four Mod V core drivers is now operating. This equipment enables cores to be driven by full- and half-amplitude pulses in both READ and WRITE directions. This is the first time half-writing pulses have been included in the modes used for core pulse testing. A new half-selected ONE, two new half-selected ZERO's, and a modified disturbed ZERO pulse output have been observed.

Production Core Tester for Prototype Cores (R. Pacl)

The index mechanism for the tester is being designed. A phosphor-bronze probe was anticipated for use, but experiments with a silver alloy indicate lower contact and body resistance which is desirable for better signal-noise ratios.

(R. F. Jenney)

Evaluation of various circuits and methods for possible use in current drivers and sense amplifiers on the automatic production tester has started.

Hysteresigraph (R. Pacl)

Work has been started on another 60-cycle hysteresigraph to supplement that already operating.

(B. Smulowicz)

The experimental current driver for the 60-cycle hysteresigraph operates satisfactorily at approximately 70-amperes peak. Since this current was found insufficient to saturate completely the F-262 cores, a new driver is being contemplated to generate a larger current.

The Coercive Force (J. B. Goodenough)

If domains of reverse magnetization are nucleated at grain boundaries as predicted in E-532, there must be a grain-boundary contribution to the coercive force, $H_c(w^*)$, which represents the resistance to Bloch wall motion by the grain-boundary-surface poles. This contribution has been calculated as

$$H_c(w^*) = \frac{\Pi}{2} I_s G \left\langle (\cos \Theta_1 - \cos \Theta_2)^2 \right\rangle$$

where I_s is the spontaneous magnetization of the material, Θ_1 and Θ_2 are the angles the spontaneous magnetization vectors of two neighboring grains make with the normal to their common boundary. G is a dimensionless factor which depends on the average shape of the individual grains. For bulk material $G \sim 1/4$.

2.31 Magnetic-Core Materials (continued)

The theory predicts, therefore, a grain-boundary contribution to coercivity of $\sim$1 Oe. for metals and 0.1 Oe. for ferrites. A reduction of $(\cos\Theta_1 - \cos\Theta_2)$ by tensile stress in 68 permalloy shows a change in coercivity of $\Delta H_c = 0.6$ Oe. Similar experiments on nickel ferrite show a $\Delta H_c \approx 0.06$ Oe. This is in good agreement with predicted values.

A similar theory for nucleation of domains of reverse magnetization at lammellar precipitates has been worked out. For a precipitate of lamellar cementite in iron it predicts a linear increase in coercivity with percent carbon content whereas a granular precipitate which nucleates closure domains would cause a variation in H_c as the two-thirds power of the percent carbon in iron. Experiments done in 1928 bear out the linear and two-thirds power relationships. Ferrites which are fired until the included voids are spheroidized should have lower coercivities and greater squareness than underfired samples.

Variation in Squareness in Ferrite Slug (P. K. Baltzer)

Toroids were cut at various orientations from a large cylindrical slug of General Ceramic Body MF-1118. Hysteresis data was taken on these toroids. A correlation was sought between the squareness ratio and the physical orientation of the toroids with respect to the original slug. The squareness was found to be independent of all physical variations except for radial distance from the symmetry axis of the cylindrical slug. Squareness was found to vary from 0.30 to 0.60 with a correlation coefficient with radial distance being -0.59. Density measurements of these samples is planned and the corresponding correlation calculation with squareness.

Metallography of Ferrites (P. K. Baltzer)

Photomicrographs were received from S. Andrew Kulin of Group 35 on ferrite samples both subjected and not subjected to a refiring technique.

During the refiring process, the General Ceramics body MF-1326B showed an increase in squareness, decrease in coercive force, and an increase in switching time. The microphotographs showed a corresponding change in microstructure. That is, the refiring process increased the grain size by approximately a factor of 2, decreased the percent voids in sample, and also spheroidized the voids. These changes in microstructure correlate with the present theories held here on switching mechanism and coercive force.

The other material examined was General Ceramics Body MF-1371 which demonstrated a very dramatic change in characteristics due to the refiring process. The change in electrical characteristics caused by the refiring technique were as follows: R_s increased from -0.35 to 0.87, the switching time increased seven fold and the coercivity also decreased. The photomicrographs showed that these changes were accompanied by a grain growth of five times the original size, the voids were spheroidized, and an elimination of a Widmanstatten structure that was observed in sample not refired. The correlation mentioned

2.31 Magnetic-Core Materials (continued)

for the material MF-1326B holds for the material MF-1371 but superimposed in these relationships is the vast effect of the Widmanstatten structure on the electrical characteristics. The total effect for the MF-1371 material is an extreme change in the effective grain size, as considered by J. Goodenough and N. Menyuk in E-532, with the corresponding change in electrical characteristics predicted by their model.

Preparation of Ferrites (F. Vinal, R. Maglio, J. Sacco)

Cores of the $MgO-Al_2O_3-Fe_2O_3$ system, for the study of the effect of I_s on the squareness ratio, have been completed. These cores have undergone firings at various schedules and are now being tested electrically.

A series of $MgO-ZnO-Fe_2O_3$ has been initiated for two reasons:

1) To obtain a sensitive adjustment of the nonmagnetic material into the ceramic body so as to study the variation of squareness ratio with I_s, and composition. This is an improvement over the Alumina Ferrite which was prepared for the same investigation.

2) To prepare a body with a lower firing temperature which will directly decrease the number of voids in the structure. Decreasing the voids will effectively decrease the value of coercivity.

The first of the cores at the $MgO-ZnO-Fe_2O_3$ system underwent firing April 24; a number of additional firings have been proposed.

Underway also is a series of $MgO-MnO-Fe_2O_3$. Initial firing date for these samples has been scheduled as April 29. The purpose of this investigation is to study the variation of I_s, so as to compare experimental data with theoretical data for this system.

(G. Economos)

Repeat firings have been made replacing toroids broken in firing or in handling. The sets are now complete covering the variables outlined in earlier reports. In these firings, discs were also prepared for use in magnetostriction, magnetic moment, conductivity, and grain-structure studies.

The problem of machine winding these toroids looks quite hopeless. Replies to inquiries show that breakage is excessive (about 90%), and the job cannot be undertaken unless some sort of reinforcement is permitted. Most machines will not even lay the wire close to the surface; the loop-and-pull method, most generally used, will not take care of sharp corners. The Lincoln Laboratory has been most cooperative in this problem, but here too the results were as outlined above. The specifications have been revised to make hand winding more feasible. A minimum of 85 turns each for primary and secondary will suffice. Other details will be worked out before the job is started.

2.31 Magnetic-Core Materials (continued)

Preliminary hysteresis tests on new compositions show that some changes give better characteristics.

Chemical Analysis of Ferrites (J. H. Baldrige)

Recent analyses include determinations of ferrous and ferric iron in two samples of magnetite. In one of these samples, a disc fired in this Laboratory, the ratio of ferric to ferrous oxide was found to be 1.04. Low temperature conductivity measurements in the Laboratory for Insulation Research indicate that the ratio may actually be nearer to unity. More precise data will be given in a later report.

Another recent analysis is that on a sample of magnesium ferrite prepared in this Laboratory. The results indicate that the composition of each constituent varies about one-half mole percent from that of stoichiometric magnesium ferrite.

X-ray Analysis of Ferrites (J. H. Epstein)

The pressure device is being put through preliminary tests, pending the availability of ferrite samples made in the large die. NiZn ferrite will be of particular interest in this experiment.

Seminar on Magnetism (A. L. Loeb)

The Néel article is gradually being "debugged." Fifteen copies of the Review of Modern Physics covering the Washington Conference on Magnetism have arrived, most of which have been distributed.

A program has been coded for use on WWI which will plot the hysteresis loop derived from the free-energy model.

2.32 Magnetic-Core Memory

Memory Test Setup I (S. Fine)

A method of sensing in which noise is cancelled is being investigated. Each core is read out twice and both outputs are compared with a differential amplifier. If the same noise is read out both times, the noise will cancel leaving only the ONE output if the core held a ONE or nothing if the core held a ZERO. Methods of delaying the signal and the possibility of using a pulse transformer as a difference device are being investigated.

Memory Test Setup V (W. Ogden, E.A. Guditz)

Three MTC memory planes are now mounted and operating in the memory rack. Preliminary margins of operation show a marked similarity of characteristics between planes. All three planes have been operated in every mode of operation possible with the tester. Planes have been operated simultaneously with various patterns, and their outputs compared successfully by parity check circuitry.

Margins of operation are being studied while varying driving currents, sensing time, sensing-amplifier gain and array terminating impedance.

Magnetic-Matrix Switch (A. Katz)

To simplify the identification of the various magnetic-matrix switches built to date, we propose the following designation: one numeral, denoting the number of output positions, connected by a hyphen to a second numeral, denoting the chronological order of construction. Thus, the switches (having 16 or more outputs) which have been constructed or are now being constructed are:

Designation	Core Material	Core Size
16-1	MF1118	F262
16-2	MF1131	F262
16-3	MF1326B	F291
16-4	MF1131	F262
32-1	MF1131	F282
32-2	MF1131	F262
32-3	MF1312	F262

The lattermost switch is nearing completion.

Preliminary single core testing with the MF1312 (F262) bodies indicates undesirable heating at rather low repetition frequencies. This problem is being investigated.

2.32 Magnetic-Core Memory (Continued)

RF Nondestructive Readout

Analytical work for the thesis is complete. All that remains is the making of a working RF readout system. A new 16 x 16 metallic plane has been constructed for this, and testing will soon begin.

Chapters 1, 2, and 3 are complete in a rough-draft sense. Chapter 4 will be concerned with experimental results.

Memory Planes for MTC (W.J. Canty, A.D. Hughes)

The memory planes, of which 17 will comprise the memory for MTC have heretofore been called "memory arrays;" they now are to be called memory planes.

Sixteen planes are now complete, one of which was built by IBM.

The 17th plane is in construction.

Z-Plane Driver (D. Shansky)

The Z-plane driver has been breadboarded and is now being debugged.

Linear-Selection Memory (K. Olsen)

Memorandum M-2110, "A Linear Selection Magnetic Memory using an Anti-Coincident Current Switch," is being typed. In the memory described, each word is selected and driven independently from a large multiposition switch. It might have the following advantages:

1. No outputs from nonselected cores.
2. No limitation to memory size by delta voltages.
3. Large unipolarity output-voltage pulses.
4. Common z and sensing winding.
5. Simpler construction because only two windings are necessary per core.

An anticoincident-current switch which operates like the coincident-current memory but with the same lack of critical current adjustments as the magnetic-matrix switch is proposed to drive the memory.

2.34 Ferroelectric Materials

Retest of 5 Glenco Materials (P-36, P-38, P-46, P-56)

(C.D. Morrison)

A retest of the 5 Glenco ferroelectric ceramics that were received last month shows that a change in the characteristics has occurred. These materials when first tested had maximum squareness ratios ranging from +0.50 to +0.61. Now, the maximum squareness ratio for these same materials range from +0.10 to +0.40.

A test to determine whether this change is caused by a change in the intimacy of the electrodes and the ceramic is being made.

2.4 Test Equipment

Test Equipment Committee (L. Sutro)

The Committee is considering purchase of an oscilloscope manufactured by the Laboratory for Electronics that contains a precision sweep delay adjustable from 5 to 5000 μsecs. With this it is possible to examine any part of a waveshape 5000-μsecs long and look at it with a fast sweep. The delay is controlled by a helipot in the delay generator.

The Committee approved purchase of a second Tektronix 180 Time Mark Generator to be used as the basis for precision measurement of time variables in magnetic-core output. The users will be Group 63.

2.5 Basic Circuits

Contacts (Single-Pulse Synchronizer) (C.A. Laspina)

Methods of generating a single standard 0.1-μsec pulse by means of a contact closing are being investigated. Most methods evaluated thus far are either too complex or operate poorly because of the stray capacity of the lines from the generating circuit to the contact.

To eliminate the stray-capacity problem, the generating circuit, if small and simple, could probably be placed at the contact thereby doing away with long leads.

High-Speed Flip-Flop (H. Boyd)

The final circuit specifications for this unit have been tentatively made but are still subject to change. This flip-flop is to drive both diode logic and gate tubes and is required to run at a maximum prf of 2 megacycles.

Testing of this unit is still underway and a great deal of further information is necessary for a full evaluation. Special test equipment will have to be constructed for some of the desired tests.

Pulse Delays (J. Woolf)

The dynamic flip-flop using a 0.45-μsec delay line was operating and some margins were taken on the circuit. The circuit consists of a gate tube driving a 0.45-μsec delay line with the output fed back into the input. It takes one pulse to initiate the circulation of pulses in the loop. Further investigation is necessary.

2.5 Basic Circuits (continued)

The variable delay line which General Radio is developing will be delayed several months due to the difficulty of obtaining a line of sufficient bandwidth.

Pulse Standardizer (J. Woolf)

A pulse standardizer developed by A.J. Cann is under investigation. This standardizer uses an off tube to standardize 0.1-μsec pulses.

Buffer Amplifier (S. Bradspies)

A panel is being built to simulate the grid circuits of 32 gate tubes which will eventually be driven by the buffer amplifier. As an approximation, each gate tube is to be represented by 15 μμf shunted by a crystal diode in series with 470 ohms. These artificial tubes are to be biased to -15 volts.

Tests are now being run to ascertain that a gate tube actually does look somewhat like the proposed representative being built.

D-C Level Inverter (J. Gillette)

A level inverter for an output level of +10 volts and -30 volts has been designed, and its construction has been started. It will use a 6145 tube.

The possibility of using 5965 tubes for a level inverter is being investigated.

2.7 Memory Test Computer

Power Supplies (R.G. Farmer)

One rectifier has been delivered to MTC and three others should be delivered next week. All the rectifiers should be assembled and delivered by May 4.

The amplifier section of the regulators is still in drafting. All drafting will be finished by the first of next week.

A study is being made to determine how much it would cost to stock the non-standard parts used in the MTC power supplies. It would be desirable to stock enough critical parts to be able to construct a power supply of any voltage upon short notice.

Core-Tube Register (K. Olsen, R. Pfaff)

An E-note describing a core-tube register that was developed for MTC is being prepared. To save time, this type of register was not installed.

In-Out (R. Pfaff)

An M-note describing MTC's terminal equipment is in process.

Digit Schematics (R. Pfaff)

Digit schematics of MTC's AR, BR, and FF Storage have been completed.

Digit-Plane Drivers (W.J. Canty, A.D. Hughes)

The digit-plane drivers are still awaiting delivery of 10-watt non-inductive resistors necessary for completion of these units.

Sense Amplifiers (W.J. Canty, A.D. Hughes)

At present the sense amplifiers are being resistance and voltage checked.

MTC Memory Rack (W.J. Canty, A.D. Hughes)

The MTC Memory Rack is now complete except for the current-control panel, which is awaiting resistors. A-c and d-c power checks have been on the rack.

2.7 Memory Test Computer (Continued)

(H. Henegar)

Drafting is now being completed on all the plug-board storage panels.

A C-size drawing has been completed of the MTC control, showing the location of all the panels.

Planning for marginal checking of the control has been started.

Memory-Switch Interwiring (J. Crane)

The memory-switch flip-flop panel and the memory-address panel, which were mentioned in the last biweekly report, have been installed in MTC.

Digit-Plane-Driver Mounting Panel (J. Crane)

The digit-plane-driver mounting panel is now being installed in MTC. This installation will be completed before April 28.

Sensing-Amplifier Mounting Panel (J. Crane)

Installation of the sensing-amplifier mounting panel has begun and will be completed before April 28.

MTC Control (H.E. Anderson, P.R. Bagley, R.A. Hughes)

The permanent version of the Control Element has been installed and cabled. Debugging is now in progress.

Control now embodies the instructions defined in M-1881-1, "Memory Test Computer: Guide to Coding and MTC Operation Code."

3.0 STORAGE TUBES (P. Youtz)

The work on the problems of lower stability failure and positive switching which has been reported in recent biweeklies was continued this period and will continue until adequate solutions are found.

The experimental work on an improved and more fully oxidized beryllium mosaic which was started this past period to eliminate some of the recent lower-stability failures did not produce the anticipated results.

The work on the envelope bakeout, stannic oxide, and vacuum firing of the ion-collector plates has temporarily eliminated positive switching in the 800-series storage tubes having these treatments. A redesign of the storage assembly to eliminate any transient breakdowns will be started this next period.

3.1 Construction (P. Youtz)

800-series storage tubes were constructed as replacements for any marginal tubes in Bank B and as replacements for the old-model tubes and marginal tubes of Bank A.

Two storage tubes with stannic-oxide instead of dag coatings were constructed this period.

3.2 Test

Television Demonstrator (D. M. Fisher)

Three storage tubes and two research tubes were pretested during this period. The two research tubes were stannic-oxide types. All five tubes were considered acceptable and were transferred to the STRT for further testing.

ST806, which failed in WWI after 161.1 hours of operation because of failure to hold a positive array, was returned to the Storage Tube Laboratory for further testing. It was immediately discovered that the tube was very gassy. A successful attempt was made to clear up the gas by reflashing the getters. Observations of the surface on the TVD revealed no new information. The ion-collector and auxiliary-collector currents were monitored for approximately 20 hours while the tube was operating with normal voltages. Little new information was recorded.

ST806 will be tested again during the next period to observe if the tube characteristics change.

3.2 Test (Continued)

Storage Tube Reliability Tester (R. E. Hegler)

ST809, ST810, and ST811 were sent to WWI. ST809 was considered marginal because of a small spot interaction area.

RT381, RT382, and RT383 all have stannic-oxide coatings and were found satisfactory for WWI use.

3.3 Research and Development

Lower Stability Failure (C. L. Corderman)

The failure of ST806 marked the first of the tubes processed with helium instead of oxygen to fail due to internal breakdown. This was also the first tube after ST802 which contained a hydrogen-fired ion-collector plate instead of a vacuum fired plate. The nature of the discharge suggested the possibility that the tube was contaminated with hydrogen gas. Beginning with ST813, we are returning to vacuum-fired ion plates, but we will use plates which have previously been hydrogen fired as a first step in the cleaning procedure.

Dynamic Instability (C. L. Corderman)

One of the prominent effects of square-to-square capacitance on the storage surface, in conjunction with the nonuniform restoring current of the holding gun, has been an effect which is best described as dynamic instability. In this phenomena, the writing of a single spot causes a large area of the surface to go positive when the holding gun is subsequently turned on. Recent indications while pretesting tubes at the TVD have been that this effect becomes worse as the collector-to-surface spacing is reduced. This is probably true because of an increased angle of incidence of the primary electrons contributing to the negative restoring loop. In one case, ST748, this effect was so severe that the tube could not be operated with normal voltages and was rejected. However, most of the closely spaced tubes have shown more of a tendency toward this condition than tubes having a collector-to-surface spacing of 4 mils or greater. A similar effect took place in digit 5B of WWI during the past week which possibly was aggravated by changing the array position. Observations on additional closely spaced tubes must be made to confirm this finding, but it appears that we will have to consider operating the tubes with different voltages. Two changes which seem to help the most are: 1. A reduction of the collector potential from its normal value of 100 to something in the vicinity of 80 volts. 2. The reduction of the holding-gun anode voltages from 350 to approximately 200 volts.

3.3 Research and Development (Continued)

"L" Cathodes (T. S. Greenwood and R. J. Biagiotti)

The required components for mounting the impregnated cathodes are presently being manufactured in the machine shop; during the next period, it is planned to build three research tubes suitable for computer use, employing the impregnated "L" cathodes in the HV gun.

The cathodes will be mounted in a manner similar to that used on the cavity-type "L" cathode by adding a ridge to the impregnated cathode and using a tantalum can for support. In at least one of these tubes a platinum-plated grid will be used for reduction of grid emission.

Two tubes previously made, using a ceramic washer supporting a cavity-type cathode, have given poor results on life testing. The first of these was pulse tested in the Life Test unit for 900 hours at which time all emission failed. The second tube has been run at zero bias for 360 hours and has shown a 70 per cent decrease in emission during this period with most of the decay occurring during the first 150 hours. The ceramic used in these tubes is a steatite which works satisfactorily with oxide cathodes but apparently is not to be recommended for use with "L" cathodes. Philips Laboratories report, however, that aluminum oxide is satisfactory and when we are able to obtain some it will be tried.

RT373-C-2 which contained an impregnated "L" cathode in the HV gun and a platinum-plated grid has run approximately 650 hours in the STRT without observable grid emission. The grid used was one which had been experimentally plated in our Chem Lab and while its physical appearance was poor, its electrical characteristics are apparently satisfactory. The reduction in grid emission cannot be attributed solely to platinum, however, since the base metal, stainless steel, has not been used alone in any tubes which have been tested for grid emission. For this reason, unplated grids will be tried in some of the tubes to be built in the near future.

Envelope Bakeout (T. S. Greenwood and R. J. Biagiotti)

The schedules used for envelope preliminary bakeouts have been continued during this period. Most of the tubes have been dag coated and the bakeout pressures have reached peaks of 6 to 7 microns. However, without assignable reason the pressures have been decreasing during the period and the most recent tube has a peak pressure of 2 microns.

To lower the pressures during the first bakeout, an oven control was installed on vacuum system #2. The peak pressures now encountered are from 5 to 7 microns. This is only a small reduction in pressure over that obtained with no oven control and while some reduction in pressure may still be possible it will require a rather large increase in the bakeout time. For this reason it is not presently contemplated unless some definite gain can be associated with such a reduction.

3.3 Research and Development (Continued)

Envelope Bakeout (T. S. Greenwood and R. J. Biagiotti) (Continued)

To relieve the processing personnel of the task of recording bakeout pressures over a continuous 4 to 5 hour period, recorders are being ordered to provide automatic recording. These will not be available for at least a month and in the interim the present recording practice will be followed.

Stannic Oxide (T. S. Greenwood and R. J. Biagiotti)

The use of stannic-oxide coatings in place of dag has resurrected the problem of gun poisoning. A survey of the 10 such tubes we have constructed shows that only 3 of the 20 guns have had emission as high as the average for such guns in the dag-coated tubes. Generally the stannic-oxide guns run 10 per cent low. Although this does not interfere with initial operation it may be inferred that the tube life is correspondingly shortened.

The cause of this poisoning is not known but it is suspected that the chemical treatment of the coating may play an important role. The next series of SnO_2 tubes will receive a special wash in HNO_3 after application of SnO_2. This wash is aimed at removing residual chlorides from the coating. In investigating possible correlations between gun poisoning and other observations on the tubes, it was discovered that a low-temperature pressure surge which occurs in dag tubes during activation is not present in stannic-oxide tubes. To provide some clarification on this point, XT68 was constructed using an LV gun in an uncoated 50-mm envelope. This tube was processed as usual and showed no pressure surge. The apparent cause of the surge in dag tubes is absorption of CO_2 by the dag during conversion, release of this CO_2 during second bakeout, and a resulting reaction between CO_2 and the cathode. The surge occurs as a result of reconversion of the cathode when its temperature is raised for activation. An attempt to eliminate this surge by running the envelope hot during conversion will be tried. If successful, the technique will be adapted largely as a precautionary measure.

Pulse Readout (A. J. Cann)

The high-velocity-gun driving circuit is undergoing some experimentation. Paine's group has wound several special pulse transformers for this work. The object is to see if spot charging can be reduced without sacrificing output, by using a shorter pulse of beam current.

The thesis is about three-fourths done in rough draft and most of the drawings are done. There will be some waveform photographs and a few more drawings after the gun driver is in shape.

A simple analysis has been developed which shows that the amplifier output is very nearly its true impulse response. This should aid in the task of prescribing amplifier alignment.

3.3 Research and Development (Continued)

Velocity Distribution Measurements (C. T. Kirk)

Construction of equipment for the 10-Kc system was completed during this biweekly period.

Preliminary tests of the 10-Kc system, using a simple 10-Kc oscillator and a single-stage 10-Kc amplifier, have been made. The severe phase shift observed in the 10-Mc system was not present in the 10-Kc system. Except at electrode potentials very close to holding-beam cutoff, there seems to be no phase shift at all.

4.0 TERMINAL EQUIPMENT (J. A. O'Brien)

The wiring schedules for the external wiring of the remote-station distribution have been completed for all equipment so far defined. These same schedules will be added to later to include the internal connections as they are defined.

The equipment for the new in-out system is beginning to arrive in quite large amounts, faster than it can be tested. The press of time in the production of some of the equipment has shown itself in many construction errors, particularly reversed and damaged crystal diodes.

The buffer storage for the first MITE rack is now being installed, and the necessary changes are being made to in-out control to accommodate it. We hope to make the equipment available to programmers next week.

Signal Wiring (G. F. Sandy)

The signal-wire cables from the remote station distribution box to AX row in the computer have been installed and connected at the RSDB end. The computer end will be connected as the panels arrive.

The signal-wire cables from the RSDB to the new control room are being prefabricated. About 18 of the 96 cables needed have been prefabricated. These 18 used all of the 20-conductor cable now on hand. 9500 feet of the cable is due to arrive April 27. This will be cut into prefabricated cables as rapidly as possible. An estimate of the cable needed showed that we will probably run a little short of that needed for the complete installation. Consequently, another 8000 feet has been ordered.

The 2 1/2" diameter holes for pulling the feed wires up through the floor to the individual pieces of equipment are being cut in the floor of the new control room. We expect to complete this by May 1.

4.1 Typewriter and Paper Tape (L. H. Norcott)

During the past two weeks, two of our "FL" punches have failed due to their 450-ohm-punch magnet coils burning out. The manufacturer now uses 900-ohm coils on their new punches. To increase the reliability of our punches, we are obtaining 900-ohm assemblies for installation in all of our "FL" punches not so equipped.

The breadboard paper-tape verifier successfully passed preliminary tests and has been set up in the Tape Room for further testing by the operators there.

4.3 Display (R. H. Gould)

The difficulties that Dumont has been having with the K1084P7M CRT's have apparently been overcome. The four CRT's that they have shipped us as good tubes are good. The two CRT's that Dumont said were bad were not very bad and would be usable in a pinch. The rest of the tubes on order are expected to come in at a slow but adequate rate.

4.3 Display (Continued)

(F. E. Irish)

The several panels of the numerical-display system which contain the circuits for generating the basic trace pattern (figure eight) have been operated together. The circuits have been adjusted so as to produce a satisfactory basic trace pattern. At the present, it is not possible to selectively intensify segments of this pattern.

This equipment has been installed into WWI, but the changes in IOC necessary to allow the numerical-display system to operate with the computer have not been made.

(S. B. Ginsburg)

The intensify-gate amplifiers were received from the vendor. They were satisfactorily video tested and are now mounted in the computer room.

The first display-gate circuits panel was received from the shop. It was video checked and each circuit satisfactorily gated an intensify-gate amplifier. It is now installed in the computer room.

The intervention-register panel, serial #1, was received from Inspection. The panel contained several shorts and many reversed crystals. It was returned to the shop for overhauling. The second time that it was tested, the panel was seen to contain many burned-out crystals. It will take about a week to put the panel in good operating condition.

The IOS driver plug-in units were received from the vendor. The testing of these units will be delayed since only half the number of required tubes are available.

(D. J. Neville)

A crystal matrix has been designed and constructed in breadboard form to convert binary light indications to an octal indication. Five such matrices will be used in conjunction with a standard indicator-light register.

An audible-alarm circuit is being designed to work from the standard indicator-light circuit also.

4.4 Magnetic Drums (K. E. McVicar)

The auxiliary-drum system has been in operation with the computer for over two weeks on a twenty-four-hour-per-day basis. So far, we have had no trouble with reliability of the system.

4.4 Magnetic Drums (Continued)

Until the advent of warm weather, we had been successful in keeping the temperature of the drum to within a few degrees centigrade. Now, however, we lack sufficient cooling capacity to keep the drum temperature down and the variation may be as much as 8°C. This situation should be remedied next week when the air-conditioning equipment for Room 156 will be turned on. In the meanwhile, the temperature variations we have been experiencing have not affected the operation of the drum system to the extent of causing errors or significantly lower power-supply margins.

5.0 INSTALLATION AND POWER

5.1 Power Distribution and Control (G. F. Sandy)

The wireways for the new control room have been completed. A connecting wireway from the remote-station distribution box to the new control room wireways is to be completed by April 27.

Power wiring in the wireways has been about 70% installed. Rack J1 is nearly completely wired for power distribution and control for the new control room.

5.2 Power Supplies and Controls

D-C Power Supplies (S. Coffin)

Work is continuing on the redesigning of the +150-volt, 50-amp regulated d-c supply for use in WWI. A simplified starting-relay circuit has been tested and found satisfactory.

A 208-230 volt phase-sequence indicator has been constructed and is available for general use.

Air Conditioning (R. E. Garrett)

We are now ready to throw the switches on the new air-conditioning system. The system will be in operation April 27 with Room 156 as a load, and the major portion of "debugging" will be completed shortly thereafter. The existing air conditioning in Room 222 will be tied into the new system on Thursday and the WWI system on the following installation period.

Building Power (R. E. Garrett)

A new main circuit breaker has been received and will be installed by an outside contractor next week.

5.2 Power Supplies and Controls (Continued)

ERA D-C Supplies (R. G. Farmer)

Two new power supplies are being planned for Room 156 equipment, -60 volts and 200 volts, 3 amperes each. Very little design work or drafting time will be required for these supplies since they will be similar to those made for MTC. Construction Requisitions have been written and shop time has been scheduled for all sections except the amplifier section. The amplifier section will require a small amount of design work and drafting time. The supplies should be constructed, tested, and installed by July 1.

Test Equipment (R. G. Farmer)

The portable resistor test load has been modified so that it may be used to test a 500-volt supply. Before modification, it could be used to test a supply with a voltage of 250 volts or less.

MTC Alternator (R. Jahn)

Magnetization curves of the alternator and its exciter have been taken. Parameter measurements and frequency-response curves should be completed within the next biweekly period.

Whittemore Building D-C Supplies (R. Jahn)

The load on the -150-volt d-c 10-amp supply will increase to 15 amps within 3 weeks. We will either install a supplementary supply or swap existing underloaded supplies. I am investigating both possibilities.

6.0 BLOCK DIAGRAMS (B. E. Morriss, G. A. Young)

The desirability of moving the scope camera from position si 500 was mentioned in a previous biweekly report, and comments were invited. No comments were received other than those initially indicating the desirability, so in the near future (two to four weeks) the camera will be moved to the new position si 004 (octal).

The first draft of a note on the operation of the indicator light and intervention registers which will be installed as a part of the in-out system has been completed. A similar note on the operation of the scope-display system is being prepared by H. Benington.

A large amount of time was spent on drawings of the buffer-drum system.

7.0 CHECKING METHODS

7.4 Marginal Checking (T. Leary)

Programmed marginal checking (PMC) will require in the Flexowriter reader a tape listing the MC lines to be varied for the test program being used. Since PMC uses a 10-digit binary code for the three decimal digits defining a line, a conversion program has been written (and checked out) which will take Flexowriter-coded MC line numbers and punch out a tape with MC line numbers in the desired code.

Our test tapes will be modified to have a second start-over point for use with PMC. The program at this point will be arranged to either read into PMC from the Flexowriter a new MC line number or perform the test program according to whether an MC excursion is in progress or not.

(J. H. Hughes, D. A. Morrison, L. L. Holmes)

The Marginal Checking System, Mod II, was installed Friday, April 17. By late Saturady morning the installation was finished and testing started. The remainder of Saturday, Sunday, and Monday was spent in testing, making timing checks with a Brush recorder, and modifying the circuits to make them more reliable and foolproof. A memorandum will soon be written which will describe the operation of the System from the point of view of the user. This will be followed by a report describing how the System works for the benefit of those who have to troubleshoot it.

The System is now in operation and may be used in all modes except Programmed Marginal Checking. The amplidyne circuits have been modified so that you can "dump" a line with a full excursion on it without causing the computer to make an error.

We expect to decide soon how exactly the Programmed Marginal Checking part of the system will be installed. This should be a relatively simple job and will be done probably within a month or so.

8.0 MATHEMATICS, CODING, AND APPLICATIONS

8.1 Programs and Computer Operation

Progress during this biweekly period on each general applications problem is given below in terms of programming hours, minutes of computer time, and progress reports as submitted by the programmers in question. One new problem (#126) was initiated during the period by D. Ross of the M.I.T. Servomechanisms Laboratory. This problem will investigate procedures for reducing very large sets of data. More details on the scope of the problem are given in the description below under problem #126. No problems were completed during the period.

Staff time is still being concentrated on the development of the comprehensive system of service routines (CS). A brief report is given under problem #100. Details will be made available upon completion of the procedures in question. In particular, output adaptation is now ready for incorporation in the CS. Detailed specifications for the automatic choice of these output routines may be found in E-516 and in D.C.L. Summary Report No. 32. Tables listing the absolute addresses (assigned by the CS) in terms of the programmer's floating addresses will now be obtained with every conversion. Programmers may obtain prints of these so-called flad tables by requesting them at the tape room.

100. Comprehensive System of Service Routines: Arden, 5 hours; Briscoe, 49 hours; Demurjian, 29 hours; Denman, 31 hours; Frankovich, 33 hours; Hazel, 12.5 hours; Helwig, 60 hours; Kopley, 34.5 hours; Porter, 26 hours; WWI, 499 minutes

Plans for modifying the Comprehensive System of Service Routines (CS) to give a direct read-in procedure and to record 556 tape on a magnetic-tape unit are now being considered. The beginnings of the direct read-in CS and the 556 CS, the beginning of the 6-way post-mortem program, the basic conversion programs and the read-in-program will be stored on group 0 of the drum. After reading in group 0 the operator will then select the desired utility program by starting over at a specified address.

Work is continuing on the modification of the CS to use two banks of ES.

The output adaptation program has been tested and is considered to be working. A few of the output blocks remain to be tested. It is hoped that this can be incorporated into the CS during the next biweekly period.

A scope post-mortem program which displays the contents of storage as octal instructions using a 3 x 5 grid has been submitted to the tape room.

The programs for the special output blocks, column, frame, ±, space, and tab have been submitted to the tape room.

The flad table and tape title display programs have been incorporated into the present CS.

8.1 Programs and Computer Operation (continued)

A new scope calibration program which displays a square and its diagonal is now available.

Helwig

101. Optical Properties of Thin Metal Films: Denman, 3 hours; Loeb, 5 hours; WWI, 0 minutes

Tape #2506 has been typed, but cannot be converted until the output adaptation and printing routines have been incorporated in the CS.

Conversion of Tape #2506 and the testing of a program for the automatic evaluation of optical constants are planned for the future.

Loeb

104. Hydro Thermal Power System; Calculus of Variations: Cypser, 15 hours; WWI, 123 minutes

Nine iterations of the three-plant mode of operation have reduced operating costs by 11% and reduced the incremental value of further change by one-half.

Additional information on the convergence and behavior of operating limitations will be sought. Consideration is being given to the addition of transmission loss to the optimization.

Cypser

106. MIT Seismic Project: Briscoe, .5 hours; WWI, 205 minutes; Simpson, 30 hours; Smith, 10 hours

Tape 2496m1 was used to compute error curves from 11 cosine predictor operators, and the variance for one seismic trace.

Tape 2439m1 was used to compute the variance for three traces and error curves from two prediction operators.

Tape 2559m0 was used to get the autocorrelation on one seismic trace.

Tape 2436m0 was used to get autocorrelations on three sets of data.

Tape 2539 was incorrectly converted. An error in the character table of a delayed-printer output program caused some trouble.

Most of the programs we need have been tested and we will be using more time for production runs in the future.

Robinson

107. (a) Autocorrelation and (b) Fourier Transform, Evaluate Integrals: Frankovich, .5 hours; Ross, 15 hours; WWI, 18 minutes

One good run of the Fourier Transform program was completed. This run, a recalculation of a certain range of frequencies with higher resolution than an earlier run, shows that negative answers, which are physically meaningless, do not appear when high resolution is used. This indicates that a very good

8.1 Programs and Computer Operation (continued)

approximation to the actual spectrum is being obtained. Tape difficulties caused lost time on other runs but these have now been corrected.

The problem will be finished with the completion of four more transform runs.

Ross

108. An Interpretive Program: Laning, 10 hours; Hazel, .5 hours; WWI, 9 minutes

Some weeks ago the initial phase of this project was successfully completed. At that time the final program for this initial phase was on several tapes. These have been combined into a single tape and the computer time used this period was devoted to testing this final tape. It was found to be correct.

Programming of the revised and expanded version is progressing as the pressure of other obligations permits.

Zierler

109. Fighter-Gunsight Calibration, 8th Order D. E.: Hellman, 30 hours; Hazel, .5 hours; Zierler, 5 hours; WWI, 10 minutes

As previously reported, the flight-equations portion of this program is now operating correctly. A modification has been made so that the delayed printer rather than the typewriter is used for output.

A modifying program has been written that is intended to replace time by range for the independent variable. It has not operated successfully and it is thought that the source of error is of a mathematical rather than of a programming nature.

Zierler

111. Fourier Analysis--Autocorrelation Problem: Hazel, .5 hours; Zierler, 10 hours:, WWI, 13 minutes

The program has been modified so that the magnetic drum rather than paper tape is used for auxiliary storage. This has resulted in a considerable saving of machine time.

There is an error in the program that has delayed completion of the problem but about 90% of the desired results have been obtained.

Zierler

112. Lawley's Method of Factor Analysis; Characteristic Vectors (modified): Denman, 4 hours; WWI, 0 minutes

The results of the first production run on this problem have been checked at the Educational Testing Service at Princeton on desk calculators, and it was found that the results of this run were correct, within a certain round-off error. The program has been rewritten by Dr. Lord in order to reduce the round-off error. However, several further changes are being discussed which would reduce the time required by the program.

Denman

8.1 Programs and Computer Operation (continued)

113. Shear Wall Analogy, Simultaneous Linear Equations: Kopley, 1 hour: Sydney, 30 hours; WWI, 16 minutes

The revised program, using the magnetic drum for auxiliary storage, is now being tested.

The single length numbers are scale factored at intermediate stages of the calculations. We hope that this scale factoring will improve the precision of the results. The use of the magnetic drum now makes it possible to analyze a larger lattice network.

Sydney

116. Torpedo Impulse Response; Convolution: Frankovich, 1 hour; Hamilton, 20 hours; WWI, 40 minutes

In this period six runs were attempted; two gave useful results. We are now in the process of evaluating the ability of one impulse response to predict the output for four different amplitude inputs.

In the four unsuccessful runs, two were due to the presence of 7th holes in the title, one was an overflow due to incorrect scaling. The trouble in the fourth run has not yet been located.

We are in the process of seeing what a Fourier Transform will do for us. If the results are good, then further reduction of data will be very easy and automatic. Otherwise, work will continue for a short time on analog computer corrections to the trial impulse responses.

Kramer

118. Quantized Group Communication and Learning; Non-Markovian Stochastic Process: Denman, 1 hour; K. Ralston, 15 hours; WWI, 91 minutes

It is not yet possible to fully ascertain the significance of the results of this problem. In the one case that has been run it has been found that the statistical model coded for Whirlwind predicts the human group performance reasonably accurately for trials after 6, but discrepancies exist between the model and data in the early trials. Whether this is a sampling difficulty or an inherent inadequacy of the model as it now stands can only be ascertained after more cases are examined.

K. Ralston

119. Spherical-Wave Propagation: A. Ralston, 20 hours; WWI, 27 minutes

This problem is in the trouble shooting stage. One programming error that has been corrected was the failure by the programmer to assign on the tape a personal parameter before it was used in the program. It is hoped that the trouble shooting is now almost completed.

A. Ralston

8.1 Programs and Computer Operation (continued)

120. Thermodynamic and Dynamic Effects of Water Injection into Gas Streams of High Temperature and High Velocity; simultaneous algebraic equations: Kopley, 1 hour; Porter, 6 hours; Gavril, 80 hours; WWI, 0 minutes

A first draft of a (15,0) program for a step-by-step solution of differential equations describing the one-dimensional aerothermopressor was completed two weeks ago. In the rewriting of this program it was found that the arithmetic manipulations necessary to maintain sufficient significant figures were becoming ponderously cumbersome.

On the basis of the inadequacy of a (15,0) treatment of this problem together with the fact that an additional bank of ES atorage is now available, the writer considered the use of the programmed arithmetic (PA) routines for eliminating the prodigious amount of "bookkeeping" that had arisen in the (15,0) program. The entire program was rewritten in about one half the time required for the original program.

This (24,6) program, occupying 1713 registers of ES storage, is now being checked and will be submitted for tape preparation during the next biweekly period.

Gavril

121. Determination of Weak Signal plus Noise Probability Functions: Sponsler, 10 hours; WWI, 0 minutes

A program was run successfully which integrated the probability density function

$$W(B) = \frac{e^{-\frac{+\phi^2+2}{2}} \; Io(\phi/\sqrt{2})}{5\phi^3} \qquad \phi = B^{1/5}$$

The trapezoidal formula was employed over three different abscissa interval ranges between 0.1 and 1000. With 0.1 as the lower limit of integration, the total integral was 0.93 rather than 1.0, the value to be expected of integration with zero as a lower limit. Zero could not be employed as a lower limit because of the singularity of the integrand at that point.

Sponsler

124. Deuteron Binding Energy and Wave Functions: Combelic, 100 hours; WWI, 407 minutes

One of the ten sets of parameters has been successfully run.

During this biweekly period, 48% of the total time used was lost due to transient malfunction of the computer arithmetic element; 15% of the total time was lost due to a hitherto undiscovered error in the programmed arithmetic subroutine.

That part of the main program which is supposed to carry from one set of

8.1 Programs and Computer Operation (continued)

parameters to the next has not yet run successfully. As soon as this is corrected, the rest of the parameters will be run.

Combelic

125. Analytical Differentiation: Nolan, 20 hours; WWI, 29 minutes

The errors in the new reordering program have been corrected. The program was tested with new functions and performed correctly.

The program has been enlarged to include the differentiation on inverse trigonometric forms. The enlarged program will be tested with functions of this nature.

Nolan

126. Data Reduction: Frankovich, 1 hour; Ross, 45 hours; WWI, 28 minutes

Problem 126 consists of a very large data reduction procedure for use in the Servomechanisms Laboratory. It will consist of many separate problems, each of which will be described in these biweekly reports as soon as work commences on the individual section. Efforts will be made to have all programs written in a general form so that they may be used by other programmers if desired.

The problem now under development consists of an automatic program which will fit a polynomial to an arbitrary function (over a suitable range of variable) to a specified degree of accuracy. The criterion for goodness of fit is the minimization of the integral of the square of the error. This is accomplished most easily by using Legendre polynomials, a type of orthogonal functions. The process as used in this problem is as follows:

1. The first eleven moments of the given function are calculated using Simpson's Rule for the evaluation of the integral.
2. The column matrix of moments thus obtained is matrix-multiplied times the triangular matrix of coefficients of the Legendre polynomials through the eleventh degree, giving an intermediate set of coefficients.
3. The column matrix of intermediate coefficients is matrix-multiplied times the transpose of the triangular matrix of coefficients of the Legendre polynomials, giving the final coefficients of the approximating polynomial.

The program will be written so that polynomials of degree less than eleven may be fitted by least squares initially. Then the polynomial will be evaluated for points corresponding to the points which define the given function, the error found, and this error plotted on the scope. If the error exceeds the specified tolerance at any point, the program will automatically proceed to fit the function with the next higher degree polynomial, in efforts to satisfy the tolerance limits. Once a satisfactory fit has been found, or the eleventh degree has been reached, the program will print out the coefficients of the desired polynomial. In all cases scope pictures of the error plots will be available so that smaller ranges of the independent variable may be intelligently chosen. (24,6) PA is used throughout, except for the accumulation of the integrals in step 1, where (30,15) PA is used, It is hoped that five decimal digits may be exactly fitted over ranges of at least 100 points for fairly smooth functions.

Steps 1, 2, and 3 have now been programmed but must be tested.

Ross

8.1 Programs and Computer Operation (continued)

127. Finite Bending of Circular Ring Plate due to Edge Moments; two coupled second order non-linear differential equations: WWI, 18 minutes; N. Hicks

128. MIT Subject 6.537 Digital Computer Applications Practice--Spring 1953: WWI, 29 minutes

Two of the eight students registered in 6.537 used WWI to work on term problems. More details of the individual term problems will be given in later reports.

Adams

130. Six-component Distillation, Variable Enthalpy and Equilibrium Data Simultaneous Non-linear Equations: WWI, 101 minutes

Work on this problem will be postponed until J.F.O'Donnell returns from a trip to Europe.

Porter

132. Revision, Extension, and Testing of Subroutine Library Used in Programs for obtaining Data for the Numerically Controlled Milling Machine; routine numerical and logical operations: Frankovich, 1 hour; Runyon, 25 hours; WWI, 7 minutes

The testing of subroutines was continued. About 30% of the total job has been completed. Difficulty was encountered due to a closed loop in a test program. The program was revised to facilitate error diagnosis. Writing and testing of routines will be continued as planned.

Runyon

133. Non-linear Meson Equation: Arden, 9 hours; Finkelstein, 15 hours; WWI, 18 minutes

The Runge-Kutta method was programmed and tested by the procedure previously outlined. An analysis of the results obtained has revealed a programming error. A program without this error has been written and awaits testing. A final program incorporating this method also awaits machine time.

Finkelstein

Computer Time

Programs	28 hours, 8 minutes
Conversion	8 hours, 25 minutes
Scope Calibration	25 minutes
Magnetic-Tape Test	23 minutes
Total Time Used	37 hours, 21 minutes
Total Time Assigned	49 hours, 26 minutes
Usable Time, Percentage	75.5%
Number of Programs Operated	133

9.0 FACILITIES AND CENTRAL SERVICES

9.1 Publications

(Diana Belanger)

The following material has been received in the Library, W2-301, and is available to laboratory personnel:

LABORATORY FILES

No.	Title	No. of Pages	Date	Author
R-220	Analysis and Design of a Digital-to-Analog Computer	166	12-1-52	R. L. Walquist
E-536	Diagnostic Programs and Marginal Checking in the Whirlwind I Computer	9	3-26-53	(N. Daggett (E. S. Rich
M-1953	Biweekly Report, April 10, 1953	39	4-10-53	
M-1957	Procedure for Preparing and Stripping Wires for MTC Memory Planes	2	4-6-53	E. A. Guditz
M-1964	WWII Memory Address Selection System, PB61	1	4-8-53	(N. Edwards (W. Papian
M-1965	Memory Digits and Read-Write System, PB62	1	4-8-53	(W. Papian (N. Edwards
M-1969	Basic Circuits-Sensing Amplifier	1	4-10-53	C. Laspina
M-1972	WWII Basic Circuits-D.C. Level Inverter	2	4-9-53	J. Gillette
M-1974	General Description of Oscilloscope Intensification Amplifier	1	4-10-53	H. Zieman
M-1977	Basic Circuits-Buffer Amplifier	1	4-13-53	S. Bradspies
M-1980	Group 63 Seminar on Magnetism, XLIX	6	5-13-53	(A. Loeb (N. Menyuk
M-1982	Proposal for 16" Magnetically Deflected Display Scopes	3	4-15-53	(J. O'Brien (R. Gould
M-1992	A Delay Line Time Pulse Distributor	2	4-17-53	S. Thompson
A-145	Time Cards	1	4-13-53	R. A. Osborne

LIBRARY FILES

No.	Identifying Information	Source
2332	The Proper Values of the Sum and Product of Symmetric Matrices	N. B. S.
2333	Quantum Dynamics, Part I	N. B. S.
2334	Magnetic Frequency Doublers	Redstone Arsenal
2335	An Experimental Rapid Access Memory Using Diodes and Capacitors	N. B. S.
2340	Operating Time and Factors Affecting It, of the ENIAC, EDVAC, and ORDVAC	Ballistic Research Labs.
2341	Coding of Problems for the ORDVAC	Ballistic Rsch. Labs.
B-251	Design for a Brain, W. R. Ashby, 1952	John Wiley & Sons
B-252	Automation, The Advent of the Automatic Factory, J. Diebold, 1952	D. VanNostrand Co.
B-253	Principles of Electronics, A. G. Kloeffler, 1942	J. Wiley & Sons

9.2 Purchasing and Stock (H.B. Morley)

Dumont has shipped 2 more K1084P7 tubes, making a total of 6 factory tested units received this month. Four K1084P19's are promised for late April.

The selenium rectifiers reported as a delayed item for the 16" scope program have been received.

A new pick-up truck is expected in two or three weeks.

General filing and catalog-library filing have fallen behind schedule. Efforts are being made to bring them up to date.

Critical items, requiring orders far in advance of need, continue as follows:

Resistors - Precision; wire-wound and carbon; power and noninductive types.
Meters - All types; and electronic measuring equipment.
Capacitors - Paper tubular and cans; plug-in electrolytics; "Vitamin Q".
Connectors - BNC; all others and plugs
Sockets - All types
Wire - All types
Transformers - All types
Barrier strips
Selenium rectifiers

9.3 Construction

Production Control (F.F. Manning)

There have been 25 Construction Requisitions totaling 358 items satisfied by Group 60 electronic shops since April 10, 1953.

There are 23 Construction Requisitions totaling 437 items under construction by Group 60 electronic shops.

For further information on the status of any particular job, please call the Production Control Office (Ext. 3492).

Outside Vendor (R.F. Bradley)

There are 20 open orders outstanding with vendors, totaling 8807 items. Deliveries in the past biweekly period have totaled 834 items. Information on specific orders may be secured from the writer (Ext. 3476).

9.4 Drafting (A.M. Falcione)

New Unit Drawings

Title	Cir. Sch.	Assy. & PL.	Al. Panel
+250 Regulator Ampl. Section MTC	C-54327	D-54501	D-54508
+150 Regulator Ampl. Section MTC	C-54525	D-54502	D-54509
+120 Regulator Ampl. Section MTC	C-54526	D-54503	D-54510
+90V Regulator Ampl. Section MTC	C-54527	D-54504	D-54511
-15/-30V Regulator Ampl. Section MTC	C-54414	D-54505	D-54512
420 In-Out Sw. Display Matrix #2 WWI	D-54384	D-54484	D-54485
420 In-Out Sw. Indicator Light Matrix WWI	D-54595	D-54596	
420 In-Out Sw. Intervention Matrix #1 WWI	D-54589	D-54590	
420 In-Out Sw. Intervention Matrix #2 WWI	D-54592	D-54593	
PIU Vector Gen. Digit Sw. Unit (Cape Cod)	SB-54546	SC-54547	
PIU Vector Gen. Sign Digit Sw. Unit(Cape Cod)	SB54544	SC-54545	
5A 115/130/150 Volt Regulator LE	C-54721	E-54716	D-54718
5A 350/400 Volt Regulator LE	C-54724	E-54729	D-54730
CRT Filter Ampl. & Pulse Gen. (Cape Cod)	SC-54770	SD-54771	E-54772
-15/-30V Regulator -200V Aux. Supply MTC	C-54577	D-54693	D-54694
Light Gun Ampl. & Pulse Gen. Mod. III (Cape Cod)	SC-54477	D-54627	E-54626
Miscellaneous panels for 16" Scope Console Listed below. (Cape Cod)			
Activate & Push Button Sw. Panel	B-54580	C-54607	C-54609
Activate Sw. Panel	B-54582	C-54608	C-54609
Activate & Ind. Light Panel	B-54579	C-54610	C-54611
Ind. Light Panel Mod.III	B-54578	C-54612	C-54613
Display Sw. Panel	B-54581	C-54411	C-54614
Data Insertion Panel Type 2-5	B-54583	C-54405	C-54406
Data Insertion Panel Type 1-5	B-54670	C-54606	C-54406
Data Insertion Panel Type 1-10	B-54584	C-54353	C-54404

10.0 GENERAL

New Non-Staff

Assunta Aprile is a new Telephone Operator-Receptionist.

Jerome Davis has joined the Whittemore Building janitor crew.

Mildred Golden is another new member of the Telephone Operator-Receptionist Group.

Robert Hoffman is a new laboratory assistant in the Power Section of Group 64.

Martin McMahon is a new member of the Construction Shop where he is a laboratory assistant.

Leo Quinn has joined Group 63 as a laboratory assistant.

10.0 GENERAL (Continued)

Esther Sidman is a new Group 61 secretary.

Barbara Searle is a new messenger girl.

Terminated Non-Staff

William Butler
Eleanore Crockett
Victor Matera
Patricia Boyd