

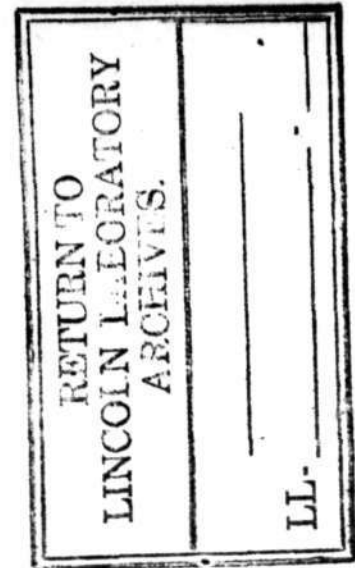
6345
Memorandum M-416

~~RESTRICTED~~
UNCLASSIFIED

Page 1 of 18

Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PART I, MAY 14, 1948
To: 6345 Engineers
From: Jay W. Forrester



1.0 WHIRLWIND I COMPUTER ELEMENTS

1.1 Listed by Block Diagram Number

101 Pulse Generator
(J. A. O'Brien)

The circuit for the pulse generator has been sketched and is now in the drafting room.

102 Program Counter
(H. Fahnestock)

Program counter video layout was received from Sylvania. This led to modifications of the circuit schematic and re-drawing of the block schematic to add a cathode follower between the flip-flop and three gate tubes. Sylvania was asked to hold up pending release of circuit schematic which has now been completed.

106 Time Pulse Distributor
(H. Fahnestock)

We have received from Sylvania and approved a proposed video layout of the output panel of the time pulse distributor.

107 Operation Matrix (Control Pulse Outputs)
(J. A. O'Brien)

The delay elements that were to be in these units have been removed, and will be put in register drivers.

The space for the delays will be left in the units, and there may be one or two cases where a delay will be inserted, such as for step counter read out since the step counter has no input amplifier. See Memorandum M-411.

UNCLASSIFIED
~~RESTRICTED~~

UNCLASSIFIED
~~RESTRICTED~~

6345
Memorandum M-416

Page 2

109 Clock Pulse Control

(J. A. O'Brien)

The gate tubes for the breadboard have been received and testing is under way. A few changes have been made in the circuit, and it is felt that amplifiers will be needed to drive the outputs. When these are added to the circuit, if enough test equipment can be obtained, it will be set up to simulate system operation.

Material for an engineering note on this unit is being prepared, and a block schematic (SB-39817) has been drawn.

203 Flip-Flop Storage

(H. Falmestock)

Complete drawings of the flip-flop storage output panel have been received from Sylvania and approved for construction of prototype.

300 Arithmetic Control

(N. Daggett)

The video layout of the divide control has been completed and construction has started.

301 A-Register

(N. H. Taylor)

Tests on the A-register will be made as soon as the accumulator panel is off the rack.

The prototype has been received from Sylvania and approval has been given to start construction of mechanical parts for production run.

Test specifications have been received from Sylvania.

302 Accumulator

(N. H. Taylor)

The preliminary test specifications for the accumulator prototype have been issued as M-396. These specs. are being used to test the panel.

The tests are proceeding normally with certain delays arising due to measuring techniques such as oscilloscope and probe calibration problems.

~~RESTRICTED~~ UNCLASSIFIED

UNCLASSIFIED

6345
Memorandum M-416~~RESTRICTED~~

Page 3

302 Accumulator (Cont'd)

A delay of several days occurred for photographs, mechanical inspection, and ohmeter tests. Every effort is being made to finish the tests by May 22, but a few more days may be needed for completion.

(G. C. Sumner)

The test of the accumulator prototype is proceeding well. In trying to establish a method of pulse voltage amplitude measurement it was found that voltmeters in the lab do not check well with each other. It seems that all voltmeters should be calibrated periodically.

601 Check Register

(H. Fahnestock)

Sylvania has been asked to hold up on the layout of the check register pending circuit schematic changes resulting from a discussion of M-401 on check register checking. A different system of check register checking will be used. Time schedules should not be affected.

1.2 System Engineering1.21 Power Control and Distribution

(C. W. Watt)

1. A basic change in the method of feeding power to the elements of the computer was required because of the trouble location methods now contemplated.
 - A. Instead of feeding power register-wise, wiring will provide digit-wise connection of computer elements. The digit columns will then be paralleled by twos.
 - B. All corresponding voltages in the registers of a digit column will be paralleled. An analysis showed some reduction could be made in the number of circuits to be varied in the marginal checking sequence.
 - C. An engineering note, E-120, defines this system.
2. Some doubt as to the types of relays to be used in the voltage variation panels has held up their layout. This question has now been settled, and layout is proceeding.

UNCLASSIFIED
~~RESTRICTED~~

UNCLASSIFIED
~~RESTRICTED~~

1.21 Power Control and Distribution (Cont'd)

3. A general meeting of all those involved in the power supply and distribution problem was held Wednesday, May 12, to bring everyone up to date. Several decisions were reached. The system as proposed seems adequate to provide the necessary power and marginal checking requirements. Detail design will now be pushed on all phases of the problem with the aim of getting enough equipment installed by August 7 to permit testing of the 16 A-register panels expected by then.

(E. S. Rich)

The proposed switching and control circuit for marginal checking has been redesigned. The revisions are described in Memo M-402.

(W. S. Rogers)

Rack material for mounting power panels and control equipment in the power room has been ordered.

Conduit from the central lab power supply has been started so that test power will be available in the computer room when needed.

Ceiling lighting in the computer room is completed as far as plans allow.

The wiring of the 75 HP synchronous condenser has been completed for testing.

The stay from the Sanborn Co. smoke stack will be removed from the computer room wall when the new Sanborn stack is installed this summer.

The laboratory central power supply system is being tested for voltage regulation. These variations will be compared with a-c regulation.

1.22 Power Cabling

(H. S. Lee)

The decision to employ digit-wise marginal checking has necessitated a revision in the design of the d-c power cabling. This revision is illustrated in Drawing D-37562 and outlined in Engineering Note E-120 which will be published within the next week.

UNCLASSIFIED
~~RESTRICTED~~

UNCLASSIFIED

6345
Memorandum M-416

~~RESTRICTED~~

Page 5

1.22 Power Cabling (Cont'd)

The revised plan does not necessitate a revision of the wire requirements that are now on requisition.

This new plan allows a more extensive use of preformed laced cable for both the inter-rack and intra-rack wiring. It is planned to have the layout and detailing of these cables completed within the next four weeks so that fabrication may begin when the wire is received. This schedule presupposes the immediate availability of one full-time draftsman in addition to those now employed on the installation phase.

1.24 Driver Panels

(N. H. Taylor)

A block schematic of register driver panels has been agreed on. This will soon be issued.

The flip-flop storage panels still need their own drivers and this panel will be designed soon.

UNCLASSIFIED

~~RESTRICTED~~

UNCLASSIFIED

6345
Memorandum M-416~~RESTRICTED~~

Page 6

1.25 Time Schedules

(R. A. Osborne)

Below is a list of time schedules showing all changes to date.

All timeschedules have been posted to the 1st of May. Prints are now being made and will be distributed to those concerned as soon as possible.

<u>Schedule Title</u>	<u>Number</u>	<u>Person Responsible</u>	<u>Coordinator</u>
<u>Repetitive Units - Sylvania</u>			
A-Register (AR 1-15)	C-31638	N. Taylor	
Accumulator (ACC 1-15)	C-31640	Watt	N. Taylor
B-Register	C-31639	N. Taylor	
Bus Drivers	C-31643	Rowland	N. Taylor
Check Register	C-31646	J. A. O'Brien	
Comparison Register	C-31648	D. Brown	
Control Pulse Outputs	C-31810	Slavin	J. A. O'Brien
Flip-Flop Storage Output	C-31642	J. A. O'Brien	
Flip-Flop Storage Register	C-31641	J. A. O'Brien	
Fuse & Variation Panels	C-31831	Anderson	Watt
Indication Panels	C-31832	Anderson	Watt
In-Out Register	C-31647	D. Brown	
Program Counter	C-31645	J. A. O'Brien	
Program Register	C-31644	J. A. O'Brien	
Register Drivers for Flip-Flop Storage Racks	C-31656	Rowland	N. Taylor
Register Drivers for Arithmetic Racks	C-31657	Rowland	N. Taylor
<u>Non-Repetitive Units - Sylvania</u>			
A-Register End Digit (AR-0)	C-31667	N. Taylor	
Clock Pulse Control	C-31653	J. A. O'Brien	
Control Switch	C-31649	Slavin	J. A. O'Brien
Delay Counter	C-31804	Kenosian	J. A. O'Brien
Frequency Divider	C-31807	Kenosian	J. A. O'Brien
Input-Output Register Control	C-31666	D. Brown	
Operation Matrix	C-31809	Slavin	J. A. O'Brien
Operation Matrix Drivers	C-31830	Slavin	J. A. O'Brien
Pulse Generator	C-31655	Kenosian	J. A. O'Brien
Restorer Pulse Generator	C-31806	Kenosian	J. A. O'Brien
Row Interlock Panels	C-31671	Anderson	Watt
Storage Switch	C-31663	J. A. O'Brien	

~~RESTRICTED~~ UNCLASSIFIED

UNCLASSIFIED

6345
Memorandum M-416~~RESTRICTED~~

Page 7

1.25 Time Schedules (cont'd)

<u>Schedule Title</u>	<u>Number</u>	<u>Person Responsible</u>	<u>Coordinator</u>
<u>Non-Repetitive Units (cont'd)</u>			
Synchronizer	C-31805	Kenosian	J. A. O'Brien
Time Pulse Distributor	C-31652	Flaherty	J. A. O'Brien
Timing Buses	C-31829	Slavin	J. A. O'Brien
Toggle Switch Storage	C-31662	J. A. O'Brien	
<u>Others</u>			
Accumulator End Digit (AC-O)	C-31668	Sumner	N. Taylor
Arithmetic Control	C-31654	(Sumner Daggett)	N. Taylor
AC-O Carry & Special Add Memory	C-31659	Sumner	N. Taylor
Add AC-O Functions on Panel Control Rack	C-31687	Sumner	N. Taylor
Divide Control	C-31660	Daggett	N. Taylor
Divide Error & Sign Control	C-31661	Sumner	N. Taylor
Multiply & Shift Control	C-31673	Daggett	N. Taylor
Point off Control	C-31686	Sumner	N. Taylor
Step Counter	C-31689	Daggett	N. Taylor
Air Conditioning of Com- puter Room	C-31681	Proctor	Forrester
Film Reader Recorder (Eastman)	C-31678	Boyd	Forrester
Operator's Console	C-31665	Watt	Everett
Preparation of Computer Room	C-31682	Proctor	Forrester
Servo & Simulation Research	C-31680	Wieser	Forrester
Storage Tube Construction - Full 5" Size	C-31669	Dodd	Forrester
Storage Tube Research	C-31685	Dodd	Forrester
Storage Tube Deflection Circuits	C-31683	Ely	Forrester
Storage Tube Output Circuits	C-31670	Campling	Forrester
Summary Power Installation	C-31686	Watt	
Power Panels	C-31859	Anderson	Watt
Power Supply (sub-contract)	C-31672	Boyd	Forrester
Power Cabling (inter- cabinet)	C-31674	Watt	
Racks (Cabinets)	C-31677	Wainwright	Watt
Stepping Relays (marginal checking)	C-31675	Rich	Watt
Video Cabling	C-31676	Watt	
Test Equipment	C-31679	Everett	Forrester
Video Amplifiers	C-31808	N. Taylor	
Trouble Location Methods	C-31684	Hoberg	Everett
Trouble Location Racks (& TSS Control)	C-31664	Watt	Everett

UNCLASSIFIED RESTRICTED

UNCLASSIFIED

6345
Memorandum M-416~~RESTRICTED~~

Page 8

1.25 Time Schedules (cont'd)

In addition to the above listed Schedules there are two other Summaries:

Master Clock C-31860 consisting of

Time Pulse Distributor
Clock Pulse Control
Pulse Generator
Delay Counter
Synchronizer
Restorer Pulse Generator
Frequency Divider

Operation Timing Control C-31650 consisting of

Operation Matrix
Control Pulse Outputs
Timing Buses
Operation Matrix Drivers

A combined summary schedule has been made to be included in the monthly Summary Reports. This schedule consists of three sheets whose numbers are 31690, 31691, 31859.

1.3 Auxiliary Equipment1.31 Power Supplies

(H. R. Boyd)

At the general meeting of the power distribution group on May 11, the plans for power supplies were consolidated, and discussions are under way with Power Equipment Co. to determine the exact specifications for design and construction of the electronic supplies. The search for a suitable A.C. generator and drive motor is also under way. The present plans are outlined in power supply proposal No. 3, (M-422) to be issued this week.

(H. S. Lee) (Filament Transformers)

The four sample filament transformers for WWI have been received from the manufacturers and testing is practically completed. It is expected that the selection of a manufacturer can be made and an order placed within the next week.

The tests to date indicate that the New England and Freed samples do not meet the efficiency specifications and that these two samples have the poorest regulation characteristics of the four samples submitted. It appears that the final choice will be made between the United and Raytheon samples.

~~RESTRICTED~~
UNCLASSIFIED

UNCLASSIFIED

~~RESTRICTED~~6345
Memorandum M-416

Page 9

1.31 Power Supplies (Cont'd)Power Distribution Racks

(R. E. Hunt)

Layout is progressing on these racks. Three layouts underway to date are:

1. Panel Selection Rack.
2. Power Junction Rack.
3. Fuse & Voltage Variation Racks.

All these layouts are dependent on each other and the layouts are progressing slowly and being continually modified as new concepts are evolved. Layout is practically parallel with the development of associated circuits.

(L. J. Nardone)

Tests were performed to determine the frequency response and phase shift of the amplidyne and its associated circuits to be used in a variable voltage supply. To date, the tests include the following:

1. Push-pull amplifier with common cathode resistor.
 - a) Without compensation.
 - b) With lead network for compensation.
2. Push-pull amplifier with degenerative cathode resistors.
 - a) Without compensation.
 - b) With lead network for compensation.

The push-pull amplifier, with degenerative cathode resistors and a lead network for compensation, gives the best frequency response and stability. Further investigation will continue in order to reduce the amount of phase shift.

1.32 Air Conditioning

(J. C. Proctor)

A conference was held with Carrier and Sylvania to discuss the layout of air ducts and methods of connecting the air supply duct to the computer cabinets. Satisfactory compromises were arrived at and Sylvania will go ahead with this final cabinet design. Carrier will work out in detail the location and arrangement of equipment, so we can draw up the necessary sketch for the pent house and sprinkler pipe layout.

The order for the construction of the pent house and putting the openings for the ducts through the roof has been placed with the C. A. Dodge Co. of Cambridge.

UNCLASSIFIED

~~RESTRICTED~~

~~UNCLASSIFIED~~
~~RESTRICTED~~

6345
Memorandum M-416

Page 10

1.4 Unclassified

Painting Computer Cabinets and Room

(J. C. Proctor)

Prof. Anderson of the Architecture Department has looked over the room and the model. He is making a study of possible color schemes, and will submit his ideas to us in the near future.

UNCLASSIFIED
~~RESTRICTED~~

UNCLASSIFIED

6345
Memorandum M- 416~~RESTRICTED~~

Page 11

1.4 UnclassifiedWVI Installation Drawing List

(C. W. WATT, Jr.)

The following drawings cover the installation of panels, racks, and wiring in WVI. This list will be kept up to date and added to as time goes by.

<u>Drawing No.</u>	<u>Title</u>
D-31793	Typical Rack Arrangements, Flip-Flop Storage and Arithmetic Element Racks.
D-37559	Cabinet Allocations, Computer Room, Barta Building.
D-37548	Layout-Cabinet Bay Locations Computer Room, Barta Building.
D-37549	Layout - Bay Cabling Ducts and Sprinkler System - Computer Room, Barta Building.
D-37553	Layout - Overhead Lighting, Computer Room.
D-37558	Layout - Air-Conditioning equipment and Duct work in Penthouse.
D-37561	Layout-Computer Room Ground System.
D-37562	Plan D. C. Power Cabling, Computer Cabinets, WVI.
D-37563	Elevations - D. C. Power Cabling, Computer Cabinets, WVI.
D-37566	Plan, A. C. Filament Cabling, Computer Cabinets, WVI.
D-37568	Plan, Interlock Relay and Indicator Light Cabling, Computer Cabinets, WVI.

UNCLASSIFIED

~~RESTRICTED~~

2.0 WHIRLWIND I RESEARCH2.1 Circuits2.11 Flip-flop Design and Stability.

(W. P. Horton)

All thesis experimental work on the a-c flip-flop has been completed.

Arrangements are being made whereby J.J.O'Brien will continue the a-c flip-flop life tests.

(R. L. Best)

Experiments with complementing on the grids of both new and old flip-flops have shown that this method is quite feasible. The chief advantages are the high impedance input to the grids, making trigger tubes unnecessary, and the eliminating of positive pips on the output waveforms. These pips were objectionable, since the restoring coupling circuit clamped to the pips. However, if this method is adopted, delay lines will be necessary in places, since the flip-flop switches on the leading edge of the pulse rather than the trailing edge.

A flip-flop is being built which will use 7AD7's and a 250 volt supply.

2.16 Basic Circuits

(R. H. Gould)

Buffer Amplifier. Engineering Notes E-115 contain the report on the testing and modification of the basic bus driver circuit BA-1. The schematic of the modified circuit is Drawing B-31721-3.

(M. H. Hayes)

Tests made on the operation of a gate tube with high and low Q coils shunting the secondary of the output transformer indicated that the Q has little or no effect upon the pulse shape, amplitude, or prf sensitivity.

In comparing iron core and air core choices of 50 μ h. inductance, the iron core chokes seem to be far better. The iron core choke has a Q of approximately 100 at 2 megacycles, as compared to 30 for the air core. This ratio is maintained up to 10 megacycles. The shunt capacitance for the iron core choke is .7 μ f. as compared to 3.0 μ f. for the air core choke, making its natural resonant frequency approximately twice as high.

~~UNCLASSIFIED~~
~~RESTRICTED~~**2.2 Components****2.22 Pulse Transformers**

(G. G. Hoberg)

Wide variations in the quality and dimensions of hipersil cores for pulse transformers are causing production difficulties at New England Transformer Company. However, at least a few hundred transformers should be available by the beginning of next week. By that time Sylvania will be prepared to run the required receiving tests, and "standard" transformers will be selected for them.

2.23 Vacuum Tube Studies

(D. R. Brown)

Professor Nottingham has suggested that the rapid deterioration of 6AG7's that we have observed at low duty factors may be explained by the formation of an interface compound. He suggests we find out what concentrations of Si, Ti, and Fe are present in the cathode Ni. Samples are being prepared.

(J. J. O'Brien)

Further calculations on the life data the 1500 hour 6AG7 tubes of the five-digit multiplier are being made.

Grid current measurements of aged 6AG7 tubes of five-digit multiplier were made at 8.5 V. on the filaments. The computations have not been completed. This data should give the temperature effects on the interface resistance in the cathode.

The vacuum tube life tests racks and associated equipment have been completed and tested. The run should start about May 18.

(Ray L. Ellis)

A second complement of 100 6AG7 tubes is being processed for pre-aging. Tube complements for other equipment are waiting for 7AK7 tubes.

The short and cathode-leakage test harness has been rebuilt. The tube checker adapters can now be used and tests made more easily.

UNCLASSIFIED
RESTRICTED

~~UNCLASSIFIED~~
~~RESTRICTED~~**2.3 Systems****2.31 Five-Digit Multiplier**

(H. L. Ziegler)

Moving and rewiring of the basement motor-generator power supplies have been completed and the multiplier has been returned to continuous operation.

When power was first applied after the shutdown, operation was very unstable and solutions were incorrect. In eliminating all causes of errors and instability, a total of nine tubes were replaced. One 1N34 crystal was also replaced because of its low back resistance. Since these changes were made, operation has been correct and very stable for both addition and multiplication.

Troubles similar to those just mentioned have occurred after most shutdowns in the past. Tests conducted on the tubes removed show the usual form of troubles without a tendency toward any particular fault. One fault that does seem to develop during periods of extended shutdown is that of poor socket contact; there have been several cases of this recently.

The +90 volt flip-flop screen voltage lead is being changed from a fixed, tap to a variable tap on each panel screen supply. When completed, this voltage will be varied to find the value best suited for checking of flip-flop sticking.

UNCLASSIFIED
~~RESTRICTED~~

~~RESTRICTED~~

3.0 SPECIAL CIRCUITS

3.2 Test Equipment

3.21 Standard Test Equipment

(R. R. Everett)

The following new items have been approved by the Test Equipment Committee:

For construction
DC Patch Cords
93 ohm Cable Terminators

For modification
Model P-1 Power Supply (for E. Sard)

For purchase
Weston Model 430 Voltmeter (for W. Rogers)
General Radio Vacuum Tube Voltmeter Mod. 1800A (for N. Taylor)

Request forms and time schedules have been issued for the above items as well as for the bulk of the items listed in the last bi-weekly report.

The need for Gate and Delayed Trigger generators has led to the assignment of a high priority for the immediate construction of 6 double units. These units will be equipped with temporary panels. They are being built in Al Taylor's shop and should be available about June 1. The remaining 19 units of the first order are due about July 1.

A prototype for R. L. Best's Oscilloscope Synchronizer has been started. Construction is proceeding of Rack Power Control Units, DC Power Distribution Strips, and Variable-Frequency Clocks. Other equipment is discussed below.

(H. Kenosian)

Register Panel. The flip-flop register panel is in the process of being designed. Tentative specifications are that the unit will have permanently connected output buffers, and will have a single capacitively-coupled input to each gate tube, and two mixer circuits to each flip-flop.

Deflection Voltage Calibrator. (SB-39814) A breadboard for a voltage calibrator for synchroscoper and synchroscope amplifier is being studied. This unit will deliver a 1, 10, or

UNCLASSIFIED

~~RESTRICTED~~

~~UNCLASSIFIED
RESTRICTED~~

3.21 Standard Test Equipment (Cont.)

(H. Kenosian cont.)

100 volt pulse of variable length up to 20 microseconds, whose amplitude will be measurable with an ordinary d-c voltmeter. The unit can be synchronized by external pulses. The rise time of the pulse is expected to be at least 0.15 microseconds.

Variable-Frequency Clock-Pulse Generator. (B-39735) Work on the prototype has been completed. Ten units will be built as soon as needed materials arrive. An engineering note is being written on this unit.

Coder. (SB-39771) A coder which will supply up to five output pulses on different channels for each input pulse has been developed. Each output can be selected with a toggle switch. The unit requires a standard 0.1 microsecond pulse of 15 to 20 volts on the input, and delivers pulses whose amplitudes are individually variable from 10 to 30 volts.

(R. L. Massard)

Power Supplies for Sylvania Testing. The necessary supplies have been sent to Sylvania. Memorandum M-409 on the supplies and modifications will be distributed shortly.

3.22 Special Test Equipment

(H. Kenosian)

Variable-Frequency Clock-Restorer Pulse Source. The delay lines have been delivered and installed in the unit, completing the entire system. The entire system consists of the adjustable scale binary counter (D-31443), clock-pulse generator (B-39735) and clock-restorer pulse source (E-31637). An engineering note on the system is being prepared.

The system will first be used to test the accumulator.

UNCLASSIFIED
~~RESTRICTED~~

4.0 BLOCK DIAGRAMS

(R. P. Mayer)

M-401 on CR checking has been issued, but is superseded by M-413 which will be issued shortly.

The EST Control system is being integrated with the rest of the computer; but this is difficult due to the number of assumptions which must be made concerning the final EST tubes and circuits.

4.1 Timing Studies

(J. M. Hunt)

In order to permit study of problems of pulse magnitude and timing on WWI a circuit has been devised which accurately simulates the electrical path through which a carry pulse traverses the numerous gate tubes and buffer amplifiers of the operation control and arithmetic element. The part of the carry pulse under circumstances which necessitate traversal of the greatest possible number of gate tubes has been chosen for investigation because it is the most lengthy and complicated pulse path which will be encountered in WWI.

UNCLASSIFIED

~~RESTRICTED~~

6345
Memorandum M-416

~~UNCLASSIFIED~~
~~RESTRICTED~~

Page 18

5.0 CHECKING METHODS

(E. Blumenthal)

Have completed thesis entitled "A Trouble-Location Scheme for a Digital Electronic Computer." The final copy is currently being typed and hectographed. The drafting room has completed all drawings, most of which have been sent out for reduction. It is expected that these will be processed in time.

UNCLASSIFIED
~~RESTRICTED~~