Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PART I, MARCH 5, 1948

To: 6345 Engineers

From: Jay W. Forrester

1.0 WHIRLWIND I COMPUTER ELEMENTS

1.1 Listed by Block Diagram Number

100 Operator's Console

(H. Kenosian)

Tests with the modified button circuits for the operator's console are under-way. Preliminary tests show that it is quite possible to use one pair of gas tubes to obtain a pulse which can be channelled into any bus. A given push-button selects a channel and fires the gas tube pulse into that channel.

104 Control Switch

(J. A. O'Brien)

Slavin of Sylvania has finished several sketches relating to the final design of the control switch. Conferences between Slavin and myself have resolved all of the obstacles in the switch design, and it has been laid aside while conferences continue on the operation matrix to make sure that the two units will work together.

105 Operation Matrix

(J. A. O'Brien)

The design details of the operation matrix are being worked out by Slavin of Sylvania. We have had several conferences and at present the principal difficulty appears to be the horizontal drivers, and the preservation of the switching waveform throughout the channel.

It has been decided to put the matrix proper in two racks with forty gate tubes above it and forty below it. Sylvania is preparing two models of packaged gate-tube units for possible use in this design.

106 Time Pulse Distributor

(J. A. O'Brien)

A new block schematic has been drawn on the Time Pulse Distributor Control, with an attempt to present more information as to components and layout. The new drawing is D-31636.

(H. Kenosian)

A circuit schematic of the Time Pulse Distributor Control based on block diagram D-31387 should be ready for the drafting room next week.

203 Flip-Flop Storage

(H. Fahnestock)

Sylvania has been authorized to proceed with layout of prototype panels of Flip-Flop Storage Register panel and Flip-Flop Storage Output panels from grade II circuit schematics, E-31621 and E-31635. M-261 dated March 5th requests preliminary rough layout by March 10th.

300 Arithmetic Control

(G. C. Sumner)

The circuit schematic of the ACO Carry and Special Add Memory panel, E-31632, is ready for publication. Panel layout drawings will begin within the next 2 weeks.

(N. Daggett)

The circuit schematic for the Multiply-Shift Control is now available, Drawing E-31588. That for the Divide Control will be available soon.

302 Accumulator

(C. W. Watt)

Schematic and parts list of Accumulator completed. Detailing of prototype panel well along, and layout almost finished. Schematic is E-31275. Drawings released to M.I.T. shop for prototype construction (M-266, March 5).

(N. H. Taylor)

The accumulator schematic has been finished and the video layout is now being checked against the circuit schematic. Construction of this unit has been delayed due to frequent minor changes. No more minor changes will be made during the constructio of the prototype unit in order to facilitate and speed up this construction.

303 B-Register

(C. W. Watt)

A layout of the B-Register was received from Sylvania February 24. It was carefully checked by N. Taylor, C. W. Watt, D. R. Brown, and inspected by others. Certain recommendations for changes were made and are written up in memo M-257, March 4. The layout looked good and the changes required are minor. Revised layout is expected from Sylvania March 9th.

1.2 System Engineering

1.21 Power Control and Distribution

(C. W. Watt)

The general power distribution system is defined by sketch SD-39603. This is a preliminary drawing, and will be done in more detail during the next two weeks. Information on power distribution panels was given to Anderson of Sylvania on sketch SB-39604, March 5.

1.23 Video Cabling

(C. W. Watt)

A visit was made February 24th to Sylvania to inspect a panel and rack mockup. Results of this meeting are covered by memo M-265. As a result of this visit a cabling layout of three adjacent racks is being made here, with the object of determining proper location of video connectors in adjacent panels.

1.3 Auxiliary Equipment

1.31 Power Supplies
(Jay W. Forrester)
The following assignments were made at a conference on power supplies and distribution. See M-262.

1. Power Supplies (generators) and main power feeders--H. R. Boyd.

2. Voltage Regulators--R. C. Wieser.

3. Power Distribution Panels for switching and inserting marginal checking voltage, and the fuse indicators and bias interlocks--Anderson of Sylvania.

4. Stepping relays for marginal checking--E. S. Rich.

5. Cabinets, Terminal Strips, Fuse Mounting--Wainwright of Sylvania

6. Power Cabling (Inter-Cabinet)--C. W. Watt.

(H. R. Boyd)

Assignments have been made for carrying out the planning and execution of the power supply selection and installation. R. Wieser and myself will submit a schedule and plans for the supplies next week.

(C. R. Wieser)

Preliminary calculations have been made to determine how the 75HP synchronous motor should be coupled to the power line to obtain effective synchronous-condenser action. Series reactors will be necessary. More exact calculations will be made after the motor has been delivered and its characteristics measured.

(H. S. Lee)

The analysis of the D.C. power requirements for WWI has been completed and recommendations have been made as to the D.C. generating machinery needed to supply the required power. The following is a brief summary of the recommended usable load at the various voltages:

Volts	Amps	Kilowatts
250	24.00	6.0
150	53.30	8.0
120	8.33	1.0
90	5.56	0.5
-15	10.00	0.15
-25	10.00	0.25
-150	6.66	1.0

In the very near future Engineering Note, E-105, will be published summarizing the results of the analysis of both the A.C. and D.C. power requirements. This note is now in the preparatory stage.

1.32 Air Conditioning

(J. C. Proctor)

A proposal has been received from General Electric, but York feels that the conditioning we require cannot be met in the manner specified. Arrangements have been made to consult with Prof. Holt of the Mech. Eng. Dept. in the hope that he can resolve the controversy.

1.33 Cabinets

(C. W. Watt)

Design sketches of a panel handle more satisfactory than that previously proposed were worked out with Wainwright of

Sylvania. He is making drawings and a sample.

Design of panel fastener brackets was worked out with Wainwright, and the airloc fasteners for the panels selected.

(R. E. Hunt)

The first of two proposals for power cabling and fusing in the racks is now being laid out. This proposal should be available within a week, and will incorporate standard telephone type "grasshopper" fuses and Jones strips.

Proposal number 2 which will incorporate special fuses to mount in standard miniature cartridge fuse clips should be available in two to three weeks.

1.4 Unclassified

Fire Protection

(J. C. Proctor)

A representative of the Rockwood Sprinkler Co. looked over the WWI area, and will present a proposal for converting the system to an air filled one which will fulfill all our requirements.

(N. H. Taylor)

In Sylvania work on testing component panels we have a choice of their using a "standard" set of tubes for each panel and M.I.T. inserting tested tubes for final use, or Sylvania inserting tested tubes and shipping the panels complete with tubes to M.I.T. There is some complication in bookkeeping in the latter method, and plans for testing the tubes become somewhat more involved. A decision on this use should be made as soon as possible so that plans for construction of additional tube testing equipment can be made if necessary.

WWI Drawing List

WWI Elements		Block Diagram	Block Schematic	Circuit Schematic
302	Accumulator		D-31213-1	E-31275
301	"A" Register		B-31211-2	D-31276-3
303	"B" Register		B-31212-2	D-31277-1
601	Check Register		B-39288	D-31515
104	Control Switch		C-31152	SC-39492
308	Divide Control		C-31552	
308	Divide Error Control		B-31576	E-31619
203	Flip-Flop Storage		SD-39278-1	
203	Flip-Flop Storage (Output)	B-37060-1		E-31635
203	Flip-Flop Storage (Register)	C-37057-1		E-31621

	WWI Elements	Block Diagram	Block Schematic	Circuit Schematic
400	Input Registers	A-37116-1		
101	Master Clock	B-37058-1		SD-39545
306	Multiply		B-31532-1	E-31588
105	Operation Matrix	C-37077-3 C-37078-2		
107	Operation Timing Matrix	C-37077-3 C-37078-2		
500	Output Registers	A-37117-1		
310	Point Off		B-31600	
102	Program Counter		B-39291	D-31516
103	Program Register		B-39289	D-31514
108	Program Timing Matrix	B-37075-1		
307	Shift		B-31532-1	E-31588
304	Sign Control		B-31576	E-31619
305	Step Counter	B-37074-2		
309	Special Add Memory		B-31575	E-31632
200	Storage	B-31150		
201	Storage Switch		C-31152	SC-39492
106	Time Pulse Distributor	B-37068	T60PD00-8	W60X6A00
106	Time Pulse Distributor Control	D-31387	D-31636	

Test Equipment Truck WWI

(R. E. Hunt)

Some investigation has been made towards locating a suitable test equipment truck for WWI. This investigation has shown that the most suitable piece of apparatus would be an elevating truck such as is commonly used for material handling, but with some modifications.

Data has been obtained on these trucks and a tentative test platform laid out large enough to incorporate the following equipment; 1 synchroscope, 1 standard relay rack, 31" high, misc. small meters, 1 spare component drawer, a power take-off panel, and some open desk space.

The size weight and cost of an appropriate truck all seem favorable. Further work leading towards a definite proposal will be done in the near future.

2.0 WHIRLWIND I RESEARCH

2.1 Circuits

2.11 Flip-flop Design and Stability

(William P. Horton)

The Bachelor's thesis proposal has been approved by the Electrical Engineering Department. Preliminary work on A-C flip-flop parameter variations has been completed and the flip-flop test rack is being arranged for marginal operation.

2.13 Bus Drivers

(C. A. Rowland)

A bus driver for the digital transfer buses has been completed. The new circuit utilizes a 5:1 transformer to slow down the rise time of the pulse going onto the bus, which greatly reduces the amplitude of the reflections. The 6Y6 is now preceded by a 7AD7 or 6AG7 which serves as a buffer-limiter. (Sylvania should receive circuit schematic March 20th as scheduled.)

Preliminary work on a gate driver for the single point and double point gate tube drivers has been started. It has been decided to use a buffer amplifier before the gate driver here also. It seems that a 6Y6 or 6L6 will be capable of driving the 32 gate tubes in the shift lines. However, reflections have to be reduced by some means and it may be necessary to use a larger tube here when a method of eliminating reflections has been worked out.

Hoberg will have more time available to assist in these problems.

2.16 Basic Circuits

(J. A. O'Brien)

Engineering Note E-104, which is being printed, contains the most up-to-date data available on all of the basic circuits. C. Rowland has developed a new bus-driver circuit which does not appear in E-104, and a separate note will be issued to cover it.

Specification tests are proceeding on basic circuits GT-1, and 1ND-1.

(J.M. Hunt)

Because of flip-flop plate circuit loading caused by the output coupling condensers and clamp diodes, the standard flip-

flop circuit with completely discharged coupling condensers (i.e., a flip-flop which has been in operation for 10,000 microseconds or longer) will not respond to the standard WW 0.1 microsecond pulses at low repetition rates. Therefore, the flip-flop restorer system is not self-starting unless the restorer pulse repetition rate exceeds a minimum critical value. To investigate the required restorer pulse repetition rate a variable frequency source of restorer pulses was required, the existing test equipment not being readily adaptable to the generation of low p.r.f. restorer pulses.

To obtain a continuously variable source of restorer pulses at low p.r.f., a standard restorer pulse generator was modified to permit triggering of the pulse circuit with the output of a Measurements Corporation square wave generator. Single or paired standard restorer pulses are obtainable at a p.r.f. from 40 cycles to 100 k.c. The pulse repetition rate can be synchronized with an external sine wave signal if desired.

(R. L. Massard)

Possible combinations of loads for gate tubes are being set up in order to simulate operating conditions, this being necessary as some of the gate tube circuit component values (tail-reversing choke, damping resistors, etc.) depend on the capacitive load on the circuit. Consideration is being given to the idea of eventually listing with each gate tube circuit the optimum choke and resistor values according to type of load. A study will be made of each specific circuit with its corresponding load under all possible operating conditions. Much more applicable and exact results are expected as a result of considering the special cases (which are not too numerous) rather than the generalized gate tube circuit which would work in all circuits but could be doing a much better job.

2.2 Components

2.22 Pulse Transformers

(G. G. Hoberg)

Three experimental pulse transformers were designed for use with 50-microsecond pulses at a 1000-2500-ohm impedance level in a storage-tube-readout circuit being investigated by C. H. Campling.

A quantity of hipersil ribbon has beenreceived from Westinghouse and will be used to construct experimental cores in an effort to make fundamental improvements in pulse-transformer designs for conventional Whirlwind circuits. Some improvement in performance and considerably greater economy of space are believed possible.

2.23 Vacuum Tube Studies

(J. J. O'Brien)

Pulsed emission tests of good and bad 6AG7 tubes were made. Because saturation current was not drawn, the results do not clearly indicate cathode poisoning. However, there were certain pecularities in the waveforms of the bad tubes. In investigating these, the capacities of the tubes while hot were measured and no difference was found between good and bad 6AG7's. A possible explanation is a coated control grid in the bad tubes. This is now being explored.

(D. R. Brown)

Pat Youtz, Ted Clough, and I visited the Sylvania Tube Plant at Emporium, Pennsylvania, on March 2. We investigated the processing which the 7AK7 will receive and found that the processing will be the best that could be obtained in a production plant. Tube-pin contact was discussed with the group at Sylvania and they stated that we would not gain anything by plating the pins or going to an octal base. They have had no experience to indicate that we will have contact difficulties. The clips in our present lock-in sockets are very good, providing one wiping and two scraping contacts. A new socket developed for Philco has slightly better clips; it would require some modification for use in WWI.

(Ray L. Ellis)

All tubes in the multiplier are now properly labelled with the new marking method.

Tube histories for about 250 tubes have been taken from note-books and recorded on cards. Most of these are tubes from the multiplier digits. Histories are being kept in card index form, however, on all tubes tested here.

The tube sockets on the control panel and step counter have been numbered, as requested, to correspond with the schematic numbers. The tubes for the components have been marked accordingly.

Inventories will be made periodically on 7AK7 tubes. Any of these tubes not being used will be kept here for distribution. The standard 7AK7 tests will be made on each tube when it comes to us.

2.24 Crystal Rectifiers

(Ray L. Ellis)

An engineering note will soon be issued on investigations on 1N38's.

2.3 Systems

2.31 5-Digit Multiplier

(N. H. Taylor)

The operation of the multiplier has been at a standstill for some weeks due to mechanical and electrical clean up and finishing operations. These operations are consuming considerable time and are interferring with our proposed life-test program for the multiplier. It has been decided however to do a rather thorough and permanent job in setting up the unit so that future work will be interrupted as little as possible.

(Hergert L. Ziegler)

The circuit-improvement program has been interrupted by the shutdown necessary for fitting of cabinets to the multiplier.

During this shutdown, No. 1 digit panel is being modified by the electronic laboratory. The experimental whiffle-tree circuit is being replaced by a permanently installed WWI type circuit. The separated flip-flop screens are being decoupled to conform to the latest design and the flip-flops themselves are being slightly modified to improve their response.

(H. Kenosian)

The crystal-controlled clock which was built in breadboard form was adapted for use in the five-digit multiplier. This clock supplies 1 megacycle and 2 megacycle clock pulses. It is not a permanent item, but was installed to insure frequency stability with changes of line voltage.

Mechanical modifications are being made on the test equipment so that it will fit into the cabinets being installed.

3.0 SPECIAL CIRCUITS

3.2 Test Equipment

(R. R. Everett)

The test equipment committee has approved the following pin arrangement for the d-c voltages described in the last bi-weekly report. The plug is the standard 12-pin Jones:

Pin No.	11	9	7	5	3	1
Voltage	6.3	+250	+150	+120	+90	+500
Voltage	6.3	GND	-150	- 25	-15	spare
Pin No.	12	10	8	6	4	2

The most used voltages will go on a standard 6 pin plug, an item of some importance in reducing the size of standard test equipment. This fact, plus the logical sequence of voltages, seems to warrant reconnecting existing equipment requiring only the new standard voltages.

It is hoped that the necessary preliminary work can be accomplished during the week of March 8 and the changeover made at the end of the week.

R. Murch will be responsible for the necessary changes in box wiring and power supplies.

H. Kenosian will be responsible for planning necessary modifications of standard laboratory equipment including seeing that drawings are changed and that equipment is sent into Murch.

It will be the responsibility of each engineer to modify or have modified his own special equipment including rack power distribution units.

The following voltages will be shut down early in the week to allow modifying the associated power supplies for the new voltages:

+300 -50
+ 50 -100

The delayed trigger generator is the first item of standard test equipment to be needed in quantity. This problem is therefore being studied and a decision as to specifications, responsibility and time scheduled should be reached next week.

3.0 SPECIAL CIRCUITS (Continued)

3.2 Test Equipment

(N. H. Taylor)

Two informal meetings with John Terzian of Sylvania have resulted in the formulation of plans for test panels which Sylvania will use in the production of multiple units in Whirlwind I. Sylvania will make a written proposal of how they plan to lay out these test panels. This will soon be available for comment by all concerned.

3.22 Special Test Equipment

(J. J. O'Brien)

Tube Ageing Rack for Sylvania and Tube Life Test Rack. The layout on these panels is completed and the orders on special material for them have been filled.

4.0 BLOCK DIAGRAMS

(E.I. Blumenthal)

Revisions to the block diagrams, as presented in R-127, have progressed. Timing diagrams are nearly ready for submission to the drafting room.

The orders td (transfer digits) and ro (remove order) have been revised to apply only to the rightmost eleven digits of a number in the Accumulator. This revision facilitates the handling of orders by differentiating between 16-digit numbers and pure orders, where the rightmost eleven digits specify a storage register.

4.1 Timing Studies

(R.P. Mayer)

Revisions to R-127 timing diagrams are nearing completion. An effort is being made to clean up all timing details, including those arising from recent changes and additions to operations. Certain operations will now make use of an eleven-digit transfer system.

A new type of diagram, a "Traffic Schedule", has been suggested. This type of diagram shows where and when information is stored or transferred, which is not clearly shown on either block diagrams or timing diagrams. A disadvantage of the "Traffic Schedule" is the new list of symbols required.

5.0 CHECKING METHODS

(G.G.Hoberg)

Work is progressing on the functional design of a system for automatically interpreting the results of trouble-location problems in terms of the location of a fault in the five-digit multiplier.

One such system has already been devised, but its use would require non-standard punched-tape equipment. The approach will be modified in an attempt to use only standard teletype equipment and standard electronic test equipment.

A time schedule will be prepared for this work to assure correlation with other activities.