Project Whirlwind
Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: BI-WEEKLY REPORT, PART I, SEPTEMBER 17, 1948

To: 6345 Engineers

From: Jay W. Forrester

1.0 WHIRLWIND I COMPUTER ELEMENTS

1.1 Listed by Block Diagram Number

105 Operation Matrix

(J. A. O'Brien)

Control Pulse Mixer - A circuit has been drawn up and tested for the control pulse mixer to be used to mix timing pulses in to the inputs of the control pulse output units. This design will be sent to Sylvania as soon as the drafting room has finished it.

203 Flip-Flop Storage

(R. H. Gould)

Tests on the flip-flop storage register and the flip-flop storage output have been discontinued again so that the final test specifications for the B-register and accumulator can be written. Slight modifications of the reset circuit of the flip-flops on the FFSR and FFSO have improved the performance and removed the difficulty of false switching of the flip-flop.

300 Arithmetic Control

(G. G. Hoberg)

The multiply-shift control panel has been tested and found satisfactory. Several minor changes in the circuit schematic have been made.

303/403 B-Register/In-Out Register

(R. H. Gould)

The final specifications for the B-register/In-Out

303/403 B-Register/In-Out Register (continued)

register digit panel have been written and are waiting for approval. Their number is S7.410-2.

305 Step Counter

(J. A. O'Brien)

Step Counter Output Panel - The block schematic circuit schematic, and the layout of the step counter output panel have been corrected to show six bus drivers instead of the five previously shown.

601 Check Register

(J. A. O'Brien)

The layout of the check register has been received from Sylvania and is being inspected.

Check Register Check - The circuit for the check register check panel has been turned over to the drafting room with the gate tube added as mentioned in the last bi-weekly report.

700 Operator's Console

(C. W. Watt)

A series of meetings were held to decide on ways and means of testing the arithmetic element before central control is available. A workable method using the prototype time-pulse distributor, the breadboard clock pulse control already developed, and a group of about 14 coders, (part of the standard test equipment line) was evolved. This method would permit multiplication or division, either step by step or in repeated cycles at the clock frequency. The studies are continuing, and space requirements in the temporary racks in the console room will soon be fixed, as well as temporary video cabling requirements. The physical structure to hold the required equipment is installed.

(R. Hunt)

Temporary Console - A temporary console consisting of 8 standard relay racks has been designed and installed in the console room.

A model 5 scope adapter to mount a model 5 scope in these racks has been designed. These will be constructed in the next two weeks.

1.2 System Engineering

1.21 Power Control & Distribution

(W. S. Rogers)

Power Room Racks - Racks to receive WWI power supplies and controls have been installed with wire way duct.

Transformer Room.- Necessary changes in power circuits have been made to be ready to connect the filament and plate alternators as well as stand-by power.

(C. W. Watt)

WWI Installation - The uprights of most of the racks have been erected. The power racks are farthest along, but still await painting, which should be done next week, after which installation of wiring will begin.

Power Control - The schematic of the power control system has been thoroughly reviewed, and several points cleared up. The final version is in the drafting room.

(R. Hunt)

Power Control Panel - for the temporary console has been designed.

Marginal Checking Panel - for the temporary console has been designed.

Blown Fuse Location Panel - for the temporary console has been designed.

Common Tie Panel - for the Power Junction Rack has been designed and graded and will be constructed immediately.

Laboratory Power Distribution Panel - for the Power Junction Rack has been designed and will be ready for construction shortly.

Power Distribution Busses - Manufacture should be complete (excluding covers) next week. Installation should be complete within two weeks.

Panel Selection Installation - The remainder of the components for this rack have been received and construction resumed. This should be complete and tested within two weeks.

1.21 Power Control & Distribution (continued)

Power Supplies Control Panel - for the power supply room. Design on this panel has been worked out and the drafting is underway. This panel will include everything but the filament sequencing circuit which will be designed at a later date by Bob Wieser and incorporated in a separate panel.

1.22 Power Cabling

(H. S. Lee)

Gavitt Manufacturing Co. submitted for approval sample cables made from our drawings. These cables were approved with several minor comments.

An order has been forwarded to Gavitt for manufacture of the External Power Cables for the Fixed Voltage Switching Panels. An additional order will be placed this week for the cables for the Fuse Indication and Digit Interlock Panels.

1.23 Video Cabling

(C. W. Watt)

A comprehensive specification, on installation, records, and marking of video cabling has been written, and will be issued under the number S7.509 when approved by MIT and Sylvania.

1.25 Time Schedules

(R. A. Osborne)

All time schedules have been posted through August 31st. Prints have been distributed to interested parties.

1.3 Auxiliary Equipment

1.31 Power Supplies

(H. R. Boyd)

Shaffer of Power Equipment informed me today that
(1) They will ship the +150 v, 50 ampere supply next week. They have completed the testing and are modifying and crating it for shipment.
(2) They expect to complete the +250, 50 ampere, and one of the 10 ampere supplies and deliver them by October 3.
(3) The remaining 10 ampere supplies should be delivered by October 15. The +48 v supply will be a little later

1.31 Power Supplies (continued)

followed by the two bias supplies (-15 v, -30 v). The bias supplies will be changed to 6 ampere Thyratron rectifier types with shunt tube outputs.

(J. C. Proctor)

Power Supply Room - The exhaust system fan has been installed and connected, and the duct work leading up through the sky light completed. The duct work in the power supply room itself will be completed next week.

(J. J. Gano)

Synchronous Motor Regulator - The time constants of the system have been measured and found satisfactory. The system's loop is ready to close. The regulator should be operating within a week.

(L. J. Nardone)

Variable Voltage - Frequency response and phase shift characteristics for the variable-voltage supply have been taken for the closed-loop system. Curves were obtained for various frequency compensating networks and several values of output filter capacitance.

The inverter amplifier stages of the variable voltage supply were redesigned to give a higher open-loop gain. A means of controlling the gain of the system will be incorporated.

(C. R. Wieser)

WWI Filament Power - Delivery of the drive motor for the filament alternator has been delayed. It should be delivered next week.

1.32 Air Conditioning

(J. C. Proctor)

Carriers working drawing for the system has been received and approved. The wiring diagram has been completed and is in the mail to us. Actual assembly of the equipment is to start next Monday. The room conditioner and the electrostatic filter will be set up first and the necessary electrical connections made so that room conditions can be controlled to some extent, even though the duct work cannot be completed until Sylvania finishes the cabinet installation.

1.4 Unclassified

(G. C. Summer & G. G. Hoberg)

Testing of Arithmetic Element - A block diagram is being prepared of the setup to be used for testing the arithmetic element as soon as it is installed in the computer room. Testing will be done through the use of standard test equipment mounted on racks in the console room. Existing preliminary models of clock pulse control and the time-pulse distributor will be used. Coders driven by the time-pulse distributor lines will perform the function of an operation control matrix.

Operations to be performed will be selected by proper setting of the output switches on the coders. Additional coders will provide three toggle-switch storage registers, and it is expected that one Whirlwind I flip-flop storage register will be available. Problems will be solved either cyclically, about once every 1000 microseconds, or at a push-button rate. During cyclic operation, the positions of all flip-flops after any arbitrary time pulse of the 8-pulse cycle will be observable by means of the indicator lights.

(M. Hayes)

Simulation of Control Pulse Outputs - The results of these tests will be issued shortly in an engineering note. These results showed that the stages involved when a pulse travels from the pulse generator to the control lines are over designed, so that no difficulties will be encountered when the units are interconnected.

WWI Drawing List		Block Diagram	Block Schematic	Circuit Schematic
	System	B-37071-5		
	Control	B-37098-4		
	Master Clock	B-37159-1		
101	Pulse Generator	A-37155-1	B-32385	E-32333-3
102	Program Counter	B-37062-4	B-32213-1	D-31516-4
103	Program Register	B-37067-2	B-39289-1	D-31276-8
104	Control Switch	B-37066-3	T60CS00-4-C	Z60CS00-A W60CS00-1-A Z60CS00-2-A
105	Operation Matrix		S600M00	Z600M00-1-C
	Control-Pulse Output		R60CP00	S60CP00-1-B
106	Time-Pulse Distributor	B-37068-3	T60PD00-8-B	
106	Time-Pulse Distributor Counter		T60PD00-3-A	Y60PD00-B
106	Time-Pulse Distributor Output		T60PD00-4-A	Z60PD00-1-A
109	Clock-Pulse Control	B-39817-1	C-32642	R-31916
110	Frequency Divider	A-37154-1	B-32264-1	R-31729-1
111	Synchronizer	---	---	---
112	Restorer-Pulse Generator	A-37160	B-32209-3	D-31909-6
200	Storage	C-37156-1		
201	Storage Switch	B-37121-1	B-32855 T60CS00-4-C	Z60CS00-A Z60CS00-2-A E-32830 R-32722
202	Toggle-Switch Storage	B-37122-2		E-32711 E-32721-1
203	Flip-Flop Storage Output	B-37060-4	B-32269	E-31635-3
203	Flip-Flop Storage Register	B-37057-3	B-32268	E-31621-3
203	Flip-Flop Storage Control	A-37061-5		
301	A-Register, Digits 1-15	B-37056-2	B-31211-3	D-31276-8

WWI Drawing List (Continued)	Block Diagram	Block Schematic	Circuit Schematic
301 A-Register, Digit 0	B-37056-2 B-37072-7	B-31574	D-31573-2
302 Accumulator, Digits 1-14	B-37063-5	D-31213-3	R-31275-4
302 Accumulator, Digit 0	B-37096-5	D-32851	R-32850
302 Accumulator, Digit 0, Aux. Panel	B-37096-5	B-32492-2	D-32602
303 B-Register	B-37097-3 B-37069-3	B-31212-3	D-31277-4
304 Sign Control & 308 Divide-Error Control		C-31576-2	E-31619-1
305 Step Counter	B-37074-5	D-31828-1	D-39764-1
305 Step Counter Output		A-32723-1	D-32735
306 Multiply & 307 Shift Control		C-31532-3	E-31588-2
308 Divide Control		C-31552-2	R-31718-3
309 Special Add Memory & ACO Carry		C-31575-2	E-31632-1
310 Point-Off Control		C-31600-5	E-31717-3
403 In-Out Register	B-37119-2	B-32434-1	D-31277-4
404 Comparison Register	B-37120-2	B-32578	E-32576-1
601 Check Register	B-39816-2	B-32577	E-32576-1
Bus Driver, Arithmetic Element		A-32297-1	D-31727-5
Bus Driver, Flip-Flop Storage		A-32296-1	D-31726-5
Register Driver, Type I		B-32207	E-32261-3
Register Driver, Type II		A-32691	D-32690
Fuse Indication Panel			W60PP00-7-C
Voltage Variation Panel			W60PP00-6-B
WWI Power-Connector Pin Connections			C-31955-4

2.0 WHIRLWIND I RESEARCH

2.1 Circuits

2.11 Flip-Flop Design and Stability

(R. L. Best)

Testing of the flip-flop in Whirlwind circuits with various combinations of gate tubes on each side is now complete. The results indicate a variation in the pulse amplitude and noise limitations for the different cases. An Engineering Note will be issued to give the details.

(J. J. O'Brien)

As a marginal checking method, varying independently, the plate voltage supplies for the two halves of the circuit is unsuccessful. Using average good tubes, the circuit stability is very sensitive to small changes in one supply. About a 5 volt change in one supply is sufficient to upset the circuit and it sticks or stalls. The circuit is extremely insensitive to any changes in a common plate voltage supply.

Raising the screen voltage on the non-conducting tube alone increases the control grid bias necessary to keep the tube cut off. The point to which the screen voltage on the off tube can be raised before the circuit sticks is a measure first of the current in the conducting tube. With average good tubes, one screen may be raised about 40 volts before the circuit sticks. With one good and one simulated bad tube, the circuit sticks at varying points of increased screen voltage depending on the value of current in the conducting tube. The difficulty with this system lies in the question of how the aging of tubes affects their cutoff point. Within a week, there will be some 7AD7 tubes from the Five-Digit Multiplier available to check somewhat the effects of aging on the cutoff point.

2.16 Basic Circuits

(A. K. Susskind)

The investigation of the trigger-tube circuit has been continued. It was found that the input impedance of the trigger-tube circuit for a short pulse is mainly capacitive. It seems unlikely that the resulting loading on the preceding stage can be reduced. Although this loading effect is quite severe,

2.16 Basic Circuits (Continued)

it was found not to be too great for the present gate-tube circuit when the plate voltage of the 7AK7 is raised to 250 volts.

(E. S. Rich)

An Engineering Note describing revisions to the Basic Circuits has been written and will be published within a few days.

2.2 Components

2.23 Vacuum Tube Studies

(R. L. Ellis)

Test records are available on samples from the first and second shipments of production type 7AK7 tubes. Distribution curves for plate and screen currents have also been made.

Distribution curves for 100 7AD7 tubes from the last shipment received are complete.

A summary report of the results of retesting 120 7AD7 tubes used about 1500 hours in the multiplier circuits is complete.

A collection of used 7AD7 and 7AK7 tubes is being made and tested for use in determining circuit tolerances.

(H. B. Frost)

Starting a study of the effects of tube and component deterioration upon the operation of WWI basic circuits.

2.31 Five-Digit Multiplier

(J. J. O'Brien)

An error checking system has been designed and is being installed in the Five-Digit Multiplier. The system operates in conjunction with the Periodic Program Control. It reads each flip-flop once in every restorer interval and records if a flip-flop is in error for an interval.

(H. L. Ziegler)

The Multiplier has been shut down and will remain out of operation for several weeks while circuit alterations to permit marginal checking are being made.

2.31 Five Digit Multiplier (Continued)

In addition to this, gate tubes are being provided at each flip-flop to check the settings of the flip-flops at the end of any given operation. This will permit error detection at a much higher rate than is possible with the present set-up.

A voltage variation panel for the Multiplier is being designed and should be completed and installed by the time the circuit alterations have been completed.

(E. S. Rich)

The necessary wiring changes for installing a marginal checking system and a single-error detection circuit on the Multiplier are being made. The marginal-checking control panel layout has been planned and is being drawn up. This panel plus the variable-voltage generator and the error-detector equipment will be mounted on a standard rack located at the right end of the Multiplier. The installation should be completed in two or three weeks.

3.0. SPECIAL CIRCUITS

3.2 Test Equipment

3.21 Standard Test Equipment

(H. Kenosian)

Experimental work on the Henry amplifier is complete. Tests will be made this week to determine the characteristics of the cathode follower probe with the amplifier.

Push Button Pulse Generator: The wiring on this unit is being altered to eliminate the extraneous transients which appear in the push-button output.

Gate and Delay Unit: Experiments are under way to eliminate the variation in amplitude of the output pulse with changes of delay.

Voltage Calibrator: The circuit has been modified to replace the 4D32 output stage with a 6L6.

Coder: Production models have been checked and found to be satisfactory.

4.0 BLOCK DIAGRAMS

(R. P. Mayer, J. M. Salzer)

Work on block diagram revisions is continuing.

A block diagram study is being made of input-output control.

Work on electrostatic storage control is still deferred until the block diagram revisions are complete.