Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

SUBJECT: BIWEEKLY REPORT, AUGUST 10, 1953

To: Jay W. Forrester

From: Scientific and Engineering Computation Group

1. MATHEMATICS, CODING AND APPLICATIONS

1.1 Introduction

During the period covered by this report 189 coded programs were run on the time allocated to the Scientific and Engineering Computation (S&EC) Group. These programs represent part of the work that has been carried on in 23 of the problems that have been accepted by the S&EC Group. Progress on each of these problems is given below in terms of programming hours, minutes of computer time, and progress reports as submitted by the programmers in question.

The system set up for allocating WWI time assigned to the S&EC Group has been temporarily discontinued. At the moment top priority for S&EC time goes to programmers who are collaborating in the development of a comprehensive system to be used in the MIT Summer Session (SS) course on digital computers. This course will be given from August 24 through September 4. Preparation for this course is consuming an increasing amount of S&EC staff time. Progress on the SS system is described under problem #140.

Two problems were completed during this period. Problem #134, which was carried out by Dr. A. Meckler of the MIT Solid State and Molecular Theory Group, has developed a routine that may be used for the evaluation of the eigenvalues of a symmetric matrix. Problem #139 has been completed by J. Porter of the S&EC Group Staff in cooperation with Dr. J. Sternberg of the Chemistry Department at Harvard University. This problem involved the calculation of theoretical line shapes for nuclear magnetic resonance absorption lines.

One new problem (#142) was initiated during this period. This problem is being carried out by R. Bart and S. Sydney of the MIT Department of Civil and Sanitary Engineering. This problem is concerned with the study of shock waves and is described below.

1.2 Programs and Computer Operation

100. Comprehensive System of Service Routines: Briscoe, 39.5 hours; Combelic, 12 hours; Denman, 31 hours; Demurjian, 15.5 hours; Frankovich, 27 hours; Helwig, 13 hours; Porter, 4 hours; WWI, 281 minutes

A modification of the present drum input program incorporating the changes described in the previous biweekly has been written and tested.

A further modification of the utility programs on group 11 is being tested. This modification provides for using an activate button and an intervention register to obtain automatic selection of a desired utility program.

Helwig

The Group 11 Scope PM has been modified to display the octal ES address every fourth line. The new start-over point is 3500 (octal).

Combelic

A new input program making use of the intervention registers is planned. It would be convenient for use with this program to have all three basic conversion programs with CS symbols (direct read-in, delayed punch, and direct punch) incorporated into one program with three entry points. The direct and delayed punch routines have been combined in this manner, and the direct read-in is being added. The separate direct basic with CS symbols must be tested first, however.

Briscoe

Modifications for CSM7, the program now being used for CS, have been prepared and tested to improve the efficiency of the recording process on magnetic-tape unit #3. The tests will be completed and the modifications inserted this period.

Frankovich

The Delayed Printer (MOA) portion of the CS was modified and tested. Since the test was successful, this routine has been recorded with the rest of CS on magnetic-tape unit #0 and is available for use.

The modes available are decimal integer, decimal fraction, fixed point with scale factor, PA scale factor, PA no scale factor, plus sign, minus sign, tab, carriage return, space, and a special case of MOA. which gives a lower case, stop, two carriage returns and a stop character. This last case should be used at the end of all recording on magnetic tape for Delayed Printer use.

Demurjian

A program was written to print a square of uniform density on the oscilloscope in the shortest possible time. This program will be used by engineers for calibrating the intensity of the oscilloscope. The program requires less time to calculate and record a point than the 160-microsecond delay count associated with each record order for the scope, which is the fundamental limit on the speed on such a program.

A program is being written for converting from double-register, floating-point binary numbers to "normalized" decimal numbers (numbers between 0.1 and 1.0, multiplied by the appropriate power of 10). This routine is to be used with the delayed printer and it is hoped that it will be appreciably faster than presently available routines. Use is made of logarithms to obtain an estimate of the exponent of 10 which is not more than 1 in error for numbers generated by the PA routines. This estimate is then corrected if necessary.

Denman

101. <u>Optical Properties of Thin Metal Films</u>: Denman, 15 hours; Loeb, 25 hours; WWI, 76 minutes

Optical constants, conductivity and dielectric constant, as well as the partial derivatives of the optical constants with respect to observed reflection and transmission have been computed and printed out by WWI for thin metal films whose thickness is known and which are deposited on a transparent backing of known index of refraction. Experimental results put into the machine include transmission and reflection by these films of radiation of known wavelength, with radiation being incident either on the film or on the backing. WWI has successfully recognized when film incidence was reported, and printed f after the result, ignoring the calculation for backing incidence when no such data were reported. When backing incidence was reported, WWI made both calculations, and reported the results for film incidence with f, for backing incidence with b at the end of the line of results. However, this latter case was run when the output equipment did not function correctly, so that some digits were reported by incorrect character. Before going into "production" the following details have to be cleared up:

1. numerical results for "backing" incidence should be obtained.

2. various modifications should be combined into one final tape, which also includes:

3. a program, which has been coded, printing out column headings for the results. Thisprogram is attached to the main tape in such a way that the headings are printed out prior to the automatic read-in of the main program. Thus whenever a batch of parameters is being calculated with the main program remaining in storage, one heading is printed out; whenever the computation has been interrupted the headings are again printed out when the program is read in again at a future time.

Loeb

106. MIT Seismic Project: Calnan, 25 hours; WWI, 75 minutes

Production for this biweekly period consisted of computing prediction errors and their time averages in the form of Error Curves. From these results ensemble (phase) averages were computed on desk calculators as a preliminary study in the programming and coding of this type of analysis for Whirlwind I. Such a procedure, it is hoped, should not only better discriminate reflections, but also provide a method of determining their respective step-out times.

Robinson

107. (a) Autocorrelation and (b) Fourier Transform, Evaluate Integrals: Trumper, 6 hours; WWI, 16 minutes

A second determination of the autocorrelation of two sets of data from rabbit intestinal-pressure records was made. The program for autocorrelation using Simpson's rule to smooth the summation of the products was applied to the data resampled at every other point of the original set of points; this was done in order to set increased τ-shifts and thus information of low frequency correlation. The results did not overlap well with those of the original correlation, and thus they confirmed that longer data runs ought to be obtained, provided deviation from statistically stationary conditions is not greatly increased. In order to see whether the second results were made inaccurate by the coarse data sampling interval, it is planned to repeat the original data using the forthcoming autocorrelation-program modification giving 300 values of τ.

Trumper

108. An Interpretive Program: Zierler, 60 hours; WWI, 33 minutes

The time used during the present biweekly period was devoted to further program testing. Several technical programming errors were detected and corrected.

An Instrumentation Lab E-report is being prepared describing the work done so far on this problem.

Zierler

112. Lawley's Method of Factor Analysis; Characteristic Vectors (modified): Denman, 16 hours; WWI, 71 minutes

The program was run successfully for an assumed rank of 4 for the correlation matrix. When the same program was run for an assumed rank of 5, an overflow occurred, indicating that the same initial values are not satisfactory for both cases. From the results of the run with a rank of 4, new initial values have been obtained and these will be used for the next run, with the rank of 5.

Denman

114. Design of Optical Instruments: Combelic, 1.5 hours; Mahoney, 30 hours; WWI, 4 minutes

A matrix inversion program was written and is now being tested, but has not run successfully yet. When completed, this program will be incorporated in a program for determining optimal lens systems. Also further parameters were prepared for ray tracing.

Mahoney

116. Torpedo Impulse Response; Convolution: Hamilton, 75 hours; WWI, 33 minutes

One out of seven runs gave useful results. Of the unsuccessful runs, two were due to illegal characters on data tapes, one due to an incorrect impulse response, one had an incorrect scale factor causing overflow and the other two did not record on magnetic tape (tapes or program error).

The Fourier Transform data has been processed. The band of frequencies in which we are interested is so small that we cannot get enough significant information about it from the Fourier Transform program. Some more convolutions will be made on Run #7 and the same impulse responses will be convolved with Run #8 imput data to see how the two runs compare.

Hamilton

119. Spherical Wave Propagation: Fox, 8.5 hours; WWI, 126 minutes

A set of useful results was obtained during this biweekly period. However, the computation still has not reached into the region of interest where a significant steepening of compression waves would lead to the development of a shock wave. A modification of the program to print fewer values and thus allow more time for computation for a given length of run has been submitted. The change should enable the computation to get further into the region mentioned.

Fox

120. Thermodynamic and Dynamic Effects of Water Injection into Gas Streams of High Temperature and High Velocity; Simultaneous differential equations: WWI, 339 minutes

Carry-overs into this period include calculations for the following two purposes: 1) continuation of several previous cases with the use of smaller increments; and 2) further study of the effect of increment size.

It will be recalled that considerable difficulty was encountered at the outset of this problem in connection with instability toward the end of the range of the independent variable. The use of a smaller increment was found in every case to alleviate this difficulty, and the cases mentioned above were continued with an increment of 1/10 the previous value.

Regarding the second group above, two runs were made, one with an increment of .005, the other .0025. These two, combined with a previous run using an increment of .01, will be used to illustrate the effect of truncation error for a typical case.

The final report is in preparation.

Gavril.

121. Determination of Weak Signal plus Noise Probability Functions: Sponsler, 5 hours; Porter, 4 hours; WWI, 4 minutes

A short test run was made and, on the basis of the results obtained, the cause of the erroneous negative function values was determined. The program has been corrected and will be run again.

Porter

123. Earth Resistivity Interpretation: Integration of empirical functions: Briscoe, 5 hours; Strickland, 10 hours; WWI, 2 minutes

A PA post mortem was obtained for tape 2293m7 and the error which has been holding up the testing of the final program was found. The corrected program for computing Bessel functions will be tested during the next biweekly period.

Strickland

126. Data Reduction: Frankovich, 5 hours; Cundiff, 80 hours; Ross, 20 hours; Hamilton, 5 hours; WWI, 113 minutes

The polynomial fit program has been run several times. The first few runs were not successful due to operator errors and tape-preparation errors. Lately, two runs have shown up program errors which have been corrected. The last run has shown that the following sections of the program work but in some cases give strange results not yet explained: moments, matrix multiplication, error determination and plot , error statistics.

A tape which will give a post mortem of information stored on the magnetic drum has been prepared but has not yet been tested.

Ross

132. Subroutine Study for the Numerically Controlled Milling Machine: Runyon, 25 hours; Frankovich, 5.5 hours; WWI, 59 minutes

A subroutine for performing Lagrangian interpolation and a subroutine for computing tool-center offsets for plane curves were successfully tested. There are still undetected errors in two other routines now under test.

Runyon

134. Numerical Diagonalization Procedure: Arden, 6.5 hours; WWI, 11 minutes

The program is in final working form and may be used by those wishing to find the eigenvalues of symmetric matrices.

Meckler

136. Matrix Equations: Arden, 13 hours; Helwig, 15 hours; WWI, 115 minutes

An investigation of the possibilities of shortening the program is being made. Little progress was made during the second week due to unavailability of machine time.

Arden

The method for matrix inversion which was discussed in the previous biweekly has been programmed and is being tested.

Helwig

137. <u>Investigation of Atmospheric Turbulence; Autocorrelation, Crosscorrelation and Fourier Transforms</u>: Block, 20 hours; Summers, 10 hours; Zierler, 2 hours; WWI, 150 minutes

Successful correlation runs were again made with 2751m2, the general cross-correlation program for 100 values of time delay. A modification of this program was made (2763ml,m2) in order to compute 300 values of time delay, but the first attempt to run was unsuccessful, due, probably, to a program error. For the present, no further work is being done on 2763 since, after a suggestion by N. Zierler, it seems likely that 2751m2 can be used to compute any desired number of time delays; this will be tried in the near future.

The Fourier transform program (2235ml8,2235p9) has been run for cosine transforms with some success.

Data run #I is almost complete and data tapes for runs #II, III and IV are being prepared. The problem completion date is now chiefly dependent on machine time availability.

Summers

138. <u>Spheroidal Wave Functions:</u> Combelic, 8.5 hours; Little, 50 hours; Corbató, 50 hours; WWI, 36 minutes

Tapes were written and tested, as machine time permitted. Difficulty was encountered because of: 1) the (24,6) PA rounds off the MRA after an <u>its</u>; 2) the new LSR (24,6) print routine (T2756m5) requires the printing of a number before any carriage returns, in order to select the option of delayed or direct print.

Little and Corbató

139. <u>Line Shape Calculation</u>: Porter, 6 hours; WWI, 86 minutes

A complete set of values for the function F (described in M-2308) were obtained using Simpson's rule with n = 50. These results have been described in a paper presented to the Gordon conference on Elastomers by Mr. H. LeClair, Dr. J. Sternberg and Professor Rochow of the Chemistry Department at Harvard University. The results will also be included in LeClair's doctorate thesis and in an ONR Project report.

Porter

140. <u>Summer Session System</u>: Combelic, 12 hours; Finkelstein, 80 hours; Frankovich, 8 hours; Gill, 77 hours; Helwig, 14 hours; Kopley, 17 hours; Rotenberg, 80 hours; Siegel, 41 hours; Vanderburgh, 12 hours; WWI, 573 minutes

The summer session (SS) conversion program is being tested. The various subroutines of the SS interpretive program are being written; only the division and multiplication routines have been tested. Output routines are also being tested and Programming for the SS mistake diagnosis has been begun.

Gill, Finkelstein, Rotenberg and Siegel

Floating-point division and multiplication subroutines have been written. Fixed-point division is being discussed.

Helwig

141. <u>S&EC Subroutine Study</u>: Combelic, 12 hours; Vanderburgh, 1 hour; WWI, 18 minutes; Frankovich, 1 hour

The (30-j,j) Delayed Printer Subroutine (File 2756) has been increased in length to 207 registers. This subroutine requires 38% less computer time to record a number than the old D.P. Subroutine (File 2299), according to an actual test on Whirlwind I, and about 10% less typing time.

Combelic

One further run was made with the Runge-Kutta subroutine test program in order to obtain a better estimate of the errors occurring in the extrapolation process. These errors do not agree with the theoretical estimate and will be studied further.

Frankovich

142. A Study of Shock Waves: Briscoe, 6.25 hours; Sydney, 30 hours; Bart, 30 hours; WWI, 72 minutes

A two dimensional grid with concentrated masses at nodal points is subjected to impulsive loads. The response of this system is to be computed from a finite difference approximation to the differential equations of motion of this system. The basic equations that will be used are:

$$\Delta^2 u_{ij} = K_1(u_{i+1,j} - 2u_{ij} + u_{i-1,j}) + K_2(u_{i,j+1} - 2u_{i,j} + u_{i,j-1}) + K_3(v_{i+1,j+1} + v_{i-1,j-1} - v_{i+1,j-1} - v_{i-1,j+1})$$

and $u(t+\Delta t) = K_4 u(t) + K_5 \Delta^2 u(t) + \ldots. K_n \Delta^m v(t)$

where u and v are components of displacement and $K_1, K_2, \ldots, K_n$ are elasticity constants.

A program that has been prepared to analyze the one-dimensional case is being tested at the present time. We were delayed by about one week when we were unable to obtain a satisfactory conversion of the program.

Sydney and Bart

1.3 Operating Statistics

1.31 Computer Time

The following indicates the distribution of WWI time allocated to the S&EC Group.

Programs	38 hours, 13 minutes
Conversion	11 hours, 25 minutes
Magnetic-Tape Test	04 minutes
Magnetic-Drum Test	17 minutes
Scope Calibration	78 minutes
Demonstrations (#131)	07 minutes
Total Time Used	51 hours, 24 minutes
Total Time Assigned	56 hours, 49 minutes
Usable Time, Percentage	90.71%
Number of Programs Operated	189

1.32 Program Time Distribution

The following table attempts to show how the WWI time expended on S&EC programs was distributed with respect to machine runs that gave meaningful results (productive computer time) and runs that gave unsatisfactory results ("lost" computer time). Productive computer time is subdivided to indicate the time involved in actual computations as contrasted with the time expended getting information out of WWI. Computer time "lost" is subdivided to show the portion of time lost due to errors in the programmer's formulation of his problem (logical errors); due to errors in the programmer's use of the WWI code, CS Conventions, etc. (technical errors); due to tape-preparation errors; due to errors by the S&EC computer operators in running the program; due to malfunctioning of terminal equipment; and finally, due to miscellaneous causes.

These times are indicated as percentages of the time listed above in section 1.31 for programs. The times used in computing these figures are extracted from the biweekly report forms submitted by the various programmers who have used S&EC allocated WWI time.

1.	Productive Computer Time	
	Computation	69.5%
	Output	11.2%
2.	Computer Time Lost Due to Programmers' Errors	
	Technical	8.5%
	Logical	0.9%
3.	Computer Time Lost Due to Other Difficulties	
	Tape Preparation	2.8%
	Operator's Errors	1.1%
	Terminal Equipment Malfunction	0.9%
	Miscellaneous	5.1%

1.4 <u>Summary of Tape Room Bulletin Board Memoranda</u> (I. Hazel)

(These memos are intended to inform programmers of changes in coding procedure, WWI facilities, etc.)

It would help alleviate the congestion during noon runs, especially, if only those persons who are scheduled for performance are in the computer room. Please try to be there at least 5 minutes prior to your run.

Until further notice programs directly concerned with the SS will get the highest priority. All requests for time on this level must be approved by M. Rotenberg

It should be remembered that the noon-hour computer session is principally scheduled for staff problems requiring the presence of several staff programmers.

<u>Subroutine for Delayed or Direct Printing of (30-j,j) Numbers</u>

Users of the "Subroutine for delayed or direct printing of (30-j,j) numbers " Tape 2756m5 should note the following:

1. The subroutine is now 207 registers
2. The very first entry to the subroutine from the main program must be to **print a number**, i.e., to either 0p2 or 10p2. (Assuming that the routine has been assigned the flad "p2".)

These entry points set the mode of printing (direct or delayed) for machine functions (a carriage return, tab, space) in the subroutine. If the above procedure is not followed, the subroutine will hang up on si 0 in register 179p2.

Output Available by CSM7

The facilities for manual intervention in the console in the computer control room are now available for use by programmers. The si addresses in octal with the decimal equivalent in parentheses are as follows:

1. Indicator register

   si 510 (si 328)

2. Insertion registers

   left: si 336 (si 216), right: si 337 (si 217)

3. Activate buttons

   upper: si 300 (si 192), digit #0

   lower: si 300 (si 192), digit #1

The sign digit of the left insertion register is controlled by the black toggle switch. When the switch is pointed up, the sign digit is zero; and when pushed to the left, a one.

See M-1985 for further details.

2. COMPUTER ENGINEERING

2.1 Associated Studies (E. J. Craig)

The previous weeks have been spent writing a first draft of the doctoral thesis on iteration procedures for simultaneous equations.

A generalized procedure has been evolved by which N-step procedures can be devised. A new formulation of the author's procedure has been devised which may be simpler than the previous formulation. It is:

$$AX = y$$

$$X_{K+1} = \frac{1}{1+n_{K-1}}\left[X_K + n_{K-1}X_{K-1} - m_K A_t V_K\right]$$

$$n_K = \frac{\left|V_K\right|^2}{\left|A_t V_K\right|^2}$$

$$n_{K-1} = m_K \frac{(A_t V_{K-1})_t\,(A_t V_K)}{\left|V_{K-1}\right|^2} \qquad \text{where } V_K = AX_K - y$$

It is hoped that roundoff error will be smaller with this arrangement.

In addition an N-step procedure has been devised for skew-symmetric matrices.

Several practical examples in the non-linear equations have been attempted and one is near solution.

A method by which roundoff error can be evaluated will be attempted on Whirlwind I. It is hoped that experimental results will be sufficient to establish the range of effectiveness of these procedures.

2.2 Group 64 (S. H. Dodd)

During the past few months, electrostatic storage has caused appreciable losses in computer time as a result of parity alarms. These have originated because of deflection-shift troubles and positive switching. In addition, electrostatic storage continues to require quite a bit of maintenance time. As the reliability figures show, the maintenance has been effective but is a drain on computer time. Magnetic-storage operation has been proven reliable in MTC, and the decision was made in the middle of this biweekly period to replace electrostatic storage in WWI with the magnetic-storage system now operating in MTC. Since MTC only has 1024 registers of storage, an additional 1024 registers will be constructed and added later. In this interim period, WWI will operate with one bank of electrostatic storage and one bank of magnetic storage.

Until magnetic storage has been installed with both banks and has proven its reliability operating with WWI, both electrostatic-storage banks will be maintained at high reliability. The expected advantages of magnetic storage are:

1. Reduced maintenance time;
2. Fewer computer alarms;
3. A thorough test of magnetic storage with a wide variety of applications programs.

2.3 WWI System Operation

2.31 Electrostatic Storage (A. J. Roberts, S. E. Desjardins)

Considerable improvement in storage reliability has been obtained by defocusing the writing beam and by the removal of three 715's which appeared to have short taps. The stannic-oxide tubes have continued to operate reliably with no indication of positive switching. Several stannic-oxide tubes will be installed next week. The majority of storage errors are being experienced during short, isolated periods of time on block-transfer orders during read-in.

2.32 Auxiliary Magnetic-Drum System (K. E. McVicar)

The auxiliary-drum system has required attention on two or three different occasions during the past biweekly period. Most significant is the trouble we have been having with the heads. The work done by ERA's representatives several weeks ago evidently reduced, but did not eliminate, the temperature and aging effects we previously had experienced. We have noticed that several tracks now give low output; these tracks have been concentrated in Group 10. This Group is no longer available to programmers and is currently being used as a source of spare heads and tracks.

One head went completely bad for an unexplained reason. This track was in Group 11 which is used to store the input program and is ordinarily not used for recording. The resistance of the head increased greatly indicating that perhaps there is a poor solder joint between the coil and plug, but this has not been investigated.

There is still some trouble with writing between the slots in the auxiliary system. This has been substantially reduced by causing the WWI voltages to go off in the proper order when the computer is shut down or switched to standby. Since it is a cumulative effect, even a little spurious writing eventually becomes a problem. We are watching the tracks and erasing those which are unusually bad while the matter of eliminating the trouble entirely is investigated.

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

During the past two weeks, four more Flexowriters have been torn down for inspection and preventive overhaul.

Three more Flexo tables were equipped with chad-disposal chutes.

Applications personnel planning to photograph printed copy from the Flexowriters are reminded that the carbon ribbon should be used in typing their copy. Bill Walker or Ralph Butt will remove the cloth ribbon and install the carbon ribbon when requested.

3. LIBRARY ACCESSIONS LISTS

The following material has been received in the Library, W2-325:

Library Files

No.	Source	Title
2447	Repr., Journal of Math. & Physics	On the Roots of Algebraic Equations
2448	NBS Tech. News Bulletin	On Germanium Diode Experience in the SEAC Program
2441	ERA	The Dual Element Magnetic Head, BuShips, NObsr 42001
B-258	John Wiley & Sons	Introduction to Number Theory
B-260	Govt. Printing Office	Tables of Chebyshev Polynomials Sn(x) and Cn(x)
B-262	John Wiley & Sons	Introduction to Solid State Physics

Laboratory Files

No.	Title	Author
M-2321	S&EC Biweekly Report	S&EC Group
M-2324	Termination of E-Series Reports	R.R.Rathbone
E-559	A Free Energy Model for the Hysteresis Loop	A. Loeb
M-2308	S&EC Biweekly Report, July 13, 1953	S&EC Group

The following material has been received by the S&EC Group Library, Barta 109.

No.	Identifying Information	Source
C-90	Symposium on Automatic Digital Computation at the National Physical Lab.	Office of Naval Research London
C-91	A Second Progress Report on German Computer Work	ONR-London
C-92	Plans for a Computing Machine at the Instituto Nazionale per Le Applicazioni Del Calcolo	ONR-London
C-93	Electronic Computer Development in the Netherlands	ONR-London
D-33	Provision for Expansion in the SEAC	NBS
C-76	Desc. of the ENIAC and Comments on Electronic Dig. Comp. Mach.	Univ. of Pa.
C-77	A Logical Coding System Applied to the ENIAC	BRL
C-81	Bibliography on Electronic Computing Feb. 1949	R. Serrell
C-82	Bibliography of Articles on Computing Machines and their Applications - Oct. 1949	G.D.McCann
C-83	Review of Electronic Digital Computers-Feb.1952	Joint AIEE-IRE Conf.
C-89	Preparation of Problems for the BRL Cal. Machines	BRL

4. Administration and Personnel

New Staff (J. C. Proctor)

Francis C. Ryder graduated from Dartmouth College in 1930. He is a transfer from the DIC office and is now an assistant to Mr. Forrester. Before joining the staff of the DIC office in 1951, Mr. Ryder was assistant to the Director of the Woods Hole Oceanographic Institute for 4 years.

Terminated Staff

J. H. Hughes
Hilda Uchiyamada

New Non-Staff (R. A. Osborne)

Arlene Berkman has joined the Drafting Room as a Detailer.

Paul Dyer is a new Group 63 Laboratory Assistant working in the Ceramics Lab.

Betty Kollet has joined Group 63 as a Laboratory Assistant to assist in core testing.

Edmund Landers is a Laboratory Assistant in Group 6345 where he is being trained as a computer operator.

Marion Oken (the wife of Stanley Oken, one of our staff members) is working in the Drafting Room as a Detailer.

James Richard is a Northeastern University Coop student working in Group 65.

Lowell Schwartz is an MIT student in Group 62.

Perry Smoot is another MIT student who has joined Group 62.

Dave Sternlight is also an MIT student. He is in Group 63.

Minerva Vahan is a Laboratory Assistant in Group 63.

Omar Wheeler is a new Technician in Group 64.

Marlene Wise has joined Group 65 as a Northeastern Coop student.

Terminated Non-Staff

Leo Sartori
Janet Taylor
Georgette Theberge