Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

SUBJECT: BIWEEKLY REPORT, OCTOBER 5, 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 190 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 program developed by Dr. A. Loeb of the M.I.T. Chemistry Department for the automatic evaluation of optical constants of thin metal films (Problem #101) is now being applied to the study of various samples.

Dr. Sponsler has successfully concluded problem #121. This problem has developed a program for calculating a probability density function resulting from the convolution of two other identical density functions.

One new problem (#147) was initiated during this period. This problem, described in detail below, concerns the solution of a 2nd order linear differential equation arising in the study of energy bands in crystals. Work on this problem is being carried out by D.J.Howarth of the M.I.T. Solid State and Molecular Theory Group.

The S&EC movie "Making Electrons Count" has been shown privately. Some of the requested suggestions will be incorporated into a revised version of the movie.

Room 10-212 in the main building of M.I.T. will be used for the handling of S&EC approved problems originating within M.I.T. This room will be staffed daily by S&EC personnel from 10 A.M to noon and 2 P.M. to 4 P.M. Equipment needed for preparing and verifying tapes will be available at all times to qualified persons. It is expected that these facilities will prove of great convenience to students in obviating the necessity of their coming over to the Barta Building.

The seminars on Computing Machine Methods are being held this term in Room 12-182 on Tuesdays at 4 P.M. The first five lectures will describe the larger computational installations that are available at the Institute.

1.2 Programs and Computer Operation

100. Comprehensive System of Service Routines: Briscoe, 30 hours; Combelic, 2.5 hours:, Denman, 63 hours; Demurjian, 10 hours; Hazel, 8 hours; Helwig, 14 hours;, Kopley, 8 hours; WWI, 265 minutes

The 3-way basic conversion program has been retyped and converted to shorten the length of the tape. Final tests, run after retyping and reconverting, uncovered two errors, one of which has been corrected and the other of which has not been explained yet.

Briscoe

The input program has been modified to provide for the erasure of storage prior to reading in a paper tape via the photoelectric or the mechanical tape reader. Erasure is accomplished by using the lower activate button.

The comprehensive system has also been modified so that the idv program block in the programmed arithmetic section is no longer optional. This change was required since some output routines require the use of the idv instruction.

An error has also been located in the instruction icsb. The use of this instruction is to be prohibited until the mistake can be corrected.

Helwig

A preliminary draft of an elementary description of the comprehensive system is being written. This will closely follow the form used in the Summer Session manual to describe the Summer Session computer.

Porter

The 4-way post mortem has been modified to use the new decoders for delayed print, to improve the format and to reduce the time for recording on magnetic tape. When using the 4-way post mortem, it is no longer necessary to give the PA post mortem first. Because of the above and to speed up the read-in time, the PA post mortem was eliminated from the tape. The PA post mortem may be given at any time since the storing of information to be post mortemed does not interfere with the pertinent registers of the PA.

Hazel

101. Optical Properties of Thin Metal Films: Denman, 5.5 hours; Loeb, 8 hours; Richmond, 12 hours; WWI, 18 minutes

The final program described in earlier reports has been used to evaluate the optical constants for 15 samples.

Loeb

106. MIT Seismic Project: Briscoe, 5 hours; Walsh, 10 hours; WWI, 104 minutes

The program for computing autocorrelations of seismic traces was modified so that it could be used to compute autocorrelations on a series of short 50 number sections in different parts of the traces. Autocorrelations were then run on 9 sections of one set of traces.

A program to compute the frequency spectrum of a curve from its autocorrelation is being tested.

Briscoe

109. Fighter Gunsight Calibration, 8th Order Differential Equation: Hazel, 2 hours; Hellman, 40 hours; Frankovich, 2 hours; WWI, 20 minutes

A new program has been prepared using a somewhat different set of nonlinear differential equations and also using the Comprehensive System of Service Routines (CS) which was not used in the previous program. The new equations were obtained by reducing the set of equations for the three-dimensional pursuit course problem. It was considered advisable to solve the two-dimensional problem making use of the CS before attempting the more complicated three-dimensional problem because answers for a particular solution of the former are available for checking purposes.

Three test runs have been made with partial success; however, there are still some difficulties which must be eliminated. Coding for the format using the delayed printer must still be corrected.

Hellman

112. Lawley's Method of Factor Analysis; Characteristic Vectors (modified): Denman, 6 hours; WWI, 28 minutes

The arithmetic overflow which occurred during the run of the program for an assumed rank of 7 for the data matrix was caused by an error in preparing a modification tape. When this error was corrected, the program ran without alarm and the results are now being examined for accuracy.

Denman

116. Torpedo Impulse Response; Convolution: Hamilton, 56 hours; WWI, 45 minutes

Fourteen convolutions were performed on WWI during the last biweekly period. Eight of these gave productive results. Of the unproductive results, 3 were due to illegal symbols on the tape, one to an incorrect nullification of 556 tape, two to trouble with the delayed printer and one to an incorrect modification made on the tape by the programmer. Corrections were made and new runs were requested. All but one of the runs have been successfully performed.

There are five more convolutions to be performed. These convolve the corrected impulse responses for one set of data with the input data for a similar set. Thus, the ability of one impulse response to predict the outputs of another set of data similar to that from which it was estimated may be evaluated.

Kramer

119. Spherical Wave Propagation: Ralston, 3 hours; WWI, 17 minutes

A run using a larger mesh width than previously used indicated that such a mesh width is too large for accurate results. Therefore, the smaller mesh width will be used in the future.

Future runs will continue the computation from the point where the last successful run terminated.

Ralston

120. Thermodynamic and Dynamic Effects of Water Injection into Gas Streams of High Temperature and High Velocity; Simultaneous Differential Equations: WWI, 17 minutes

The computations during this period were either continuations or corroborations

of previously computed cases. The need for such additional information arose during the preparation of the graphical summary of the results.

Gavril

121. Determination of Weak Signal plus Noise Probability Functions: Porter, 4 hours; Sponsler, 75 hours; WWI, 38 minutes

The correction of the programming error mentioned in the last biweekly allowed the program to run through successfully. The program correctly computed a probability density function resulting from the linear superposition of two other identical density functions. A detailed description of the problem will be given in Digital Computer Laboratory Summary Report No. 35. The problem is now considered complete.

Sponsler

126. Data Reduction: Ross, 40 hours; Hamilton, 10 hours; Frankovich, 3 hours; WWI, 136 minutes

Efforts during this period have been directed toward getting the Mistake Diagnosis Routine working. Several errors due to the use of absolute and relative addresses rather than floating addresses have been found. Thus far no logical programming errors have been found, all errors have arisen from numbering or copying. The automatic set-up routines have been completely tested and further tests should proceed rapidly.

Ross

131. Special Problems (Staff training, demonstrations, etc.): Kopley, 8 hours; WWI, 63 minutes

The Digital Computer Laboratory was host to forty students and faculty members of the Worcester Polytechnic Institute on 25 September.

The visitors were given a one-hour lecture (with slides), a Flexowriter demonstration, a tour of the installations and a demonstration on Whirlwind.

There were several showings of the movie, "Making Electrons Count", which is a group 6345 project. The film satisfied expectations for the results of a first attempt. However, many excellent suggestions, made by laboratory personnel, will be incorporated into the second attempt. Work is now under way for what is expected to be a vastly improved version.

Kopley

132. Subroutine Study for the Numerically Controlled Milling Machine: Runyon, 30 hours; Frankovich, 7 hours; WWI, 15 minutes

Of the three runs made in this biweekly period, one was successful, one was unsuccessful because of an error in data, and one was partially successful with one portion of the program operating correctly and one portion still unsatisfactory due to undetermined causes.

Runyon

137. Investigation of Atmospheric Turbulence; Autocorrelation, Crosscorrelation and Fourier Transforms: Summers, 20 hours; Block, 10 hours; Kopley, 1 hour; WWI, 105 minutes

Additional check runs indicate satisfactory repeatability of the crosscorrelation program for 100 values of the data time spacing. The result of one anomalous run is being disregarded.

Several unsuccessful attempts were made to extend the known range of one of the autocorrelation functions to 300 times the basic time increment using Ross' program (T-2345ml4). The data tape stopped each time on read-in in a register indicating an illegal character although a visual check of the data tape indicated no such character. Another data tape will be tried and, if still unsuccessful, the program will be re-checked.

It is now felt that the correlation phase of the problem is complete, with the possible exception of two or three runs for 300 correlation points.

Difficulties are still being experienced with the Fourier transform program. The negative trends in the power spectra (apparently due to cumulative errors in sine and cosine computation) were still present when the transform was taken several times over restricted frequency bands. A program modification seems necessary and is being worked on by C. Block.

Once the Fourier transform program is suitably modified, an estimated 2 1/2 hours of computer time will be needed to complete the problem.

Summers

138. Spheroidal Wave Functions: Little, 15 hours; Corbató, 100 hours; Combelic, 4 hours; WWI, 34 minutes

The Layout Program has now been completely tested.

The Ratio Converter and Coefficient accumulator programs are being tested; the ratio-calculation program is being completed and testing by sections is continuing.

Two program failures during this period were due to: 1) the "Additional Buffer" Subroutine #2767 requires the buffer section in the PA so that a pseudo order (e.g., icab) must be used somewhere in the program to call in the buffer section of the PA routines; 2) the fact that the instruction icsb is not performed correctly by the PA routine (cf. report on problem #100).

Little and Corbató

140. Summer Session System: Combelic, 35 hours; Frankovich, 27 hours; Siegel, 59 hours; WWI, 194 minutes

The input-output routines of the Summer Session Computer have been modified to permit the use of standard tables of Flexowriter characters whenever these characters are referred to. The octal values of the characters are used in order to permit easy reading of the Flexowriter tapes. However, the computer handles the values as if they were decimal integers, so that the external appearance of decimal input and output is retained for the programmer's convenience.

The use of the tape punch as an output device has been eliminated. Instead, the choice of delayed or direct typing is provided, with delayed typing considered the "normal" mode. This change has been incorporated in both the numerical-typing and character-typing instructions.

An instruction which operates the oscilloscope camera has been added.

The modifications outlined are undergoing extensive tests. Several programming errors were discovered and corrected. Tests will continue during the next biweekly period.

A revision of the section of the Summer Session Notes dealing with input-output has been completed. The revision incorporates the changes described above.

Siegel

142. A Study of Shock Waves: Sydney, 80 hours; Bart, 80 hours; Combelic, 2 hours; WWI, 379 minutes

We have tested each section of our program for the two-dimensional shock-wave problem. Each individual unit is performing properly. We now plan to test the program as a whole, before making any production runs.

A new program for the one-dimensional problem was written in the last period. This program was prepared to give a closer approximation to the distributed mass system we are studying than was given by the original program we prepared for this analysis. We are testing this program at the present time.

Sydney

143. Vibrational Frequency Spectrum of a Copper Crystal; Third Order Polynomial: Jacobsen, 20 hours; Corbató, 20 hours; Combelic, 3.5 hours; WWI, 56 minutes

The problem is that of solving a 3 x 3 secular determinant, each term of which consists of a finite Fourier Series of 12 terms. The solution of this equation gives the frequency as a function of wavelength for elastic waves of thermal agitation propagating through the face-centered-cubic crystal lattice of copper. This equation must be solved for 25,495 different values of the wave-propagation vector. To date, the control program which selects these wave vectors has been perfected. This represents approximately one tenth of the problem. The remainder of the problem consists of multiplicative, sine-function generation, and square-root operations. This calculation is part of a Ph.D. Physics Thesis.

Jacobsen

146. Largest Eigenvalue of Real, Symmetric Matrix: Temkin, 4 hours; Siegel, 2.5 hours; WWI, 19 minutes

The program as originally written had the following defect. For each matrix of different order whose highest eigenvalue was to be found a different subroutine had to be incorporated on the punched paper tape. This defect has now been removed. One has merely to sp to the subroutine for whatever matrix one wants to solve. The exact reference for each matrix should look like:

pl,sp -----	(address of register in which subroutine starts)
n	(order of matrix)
all	(address in which first matrix element is to be stored)
yl	(address where first component of eigenvector is to be stored)
xl	(address where highest eigenvalue is to be stored)

The matrix elements should be stored double-length (24,6), consecutively, in the order a_{11}, a_{12}, $\cdots a_{1n}$, a_{21}, a_{22}, $\cdots a_{2n}$, $\cdots$, a_{nn}

Space should be left after yl for the rest of the components of the n-component eigenvector so that in all there are 2n consecutive registers for the n double length (24,6) numbers.

λ is also a double-length (24,6) number so two consecutive registers should be left open starting at xl.

The control is returned to 5pl.

Temkin

147. Energy Bands in Crystals: Howarth, 16 hours; Arden, 16 hours; WWI, 22 minutes

Approximate solutions $P_\ell(r,E)$ are required for the differential equation arising in the study of energy bands in crystals

$$\frac{d^2P_\ell}{dr^2} = P_\ell\left[\frac{\ell(\ell+1)}{r^2} - V(r) - E\right]$$

These approximate solutions will be found using two starting values near r = 0 and the Gauss-Jackson formula for forward integration

$$P_\ell = h^2\left(\tfrac{1}{2}P_\ell'' + \delta^{-2}P''\right)$$

where h is the interval of r and $P_\ell'' = \frac{d^2P_\ell}{dr^2}$. The notation δ^{-2} is to be interpreted by formally multiplying the equation by δ^2 and treating δ^2 as a second difference operator. Iterations using this formula will be made without advancing the independent variable until the values of P_ℓ converge. At this time the value of the independent variable will be increased by h and a new trial value of P_ℓ obtained using the same formula. Solutions are desired for 160 values of E and 13 values of ℓ.

In addition to the above, approximations to the expressions

$$V_\ell(E,r) = \frac{r^2}{P_\ell}\frac{dP_\ell}{dr} - r$$

$$F(E,E_0,r) = \sum_\ell (2\ell+1)j_\ell^2(\sqrt{E_0}\,r)V_\ell(E,r)$$

will be calculated for 8 values of r, 160 values of E, and 70 values of E_0. $j_\ell(x)$ is the spherical Bessel function

$$j_\ell(x) = \sqrt{\frac{\pi}{2x}}\, J_{\ell+\frac{1}{2}}(x)$$

These functions will be computed using the recurrence formula

$$j_{\ell+1} = \frac{2\ell+1}{x} j_\ell - j_{\ell-1}$$

with initial values

$$j_0 = \frac{\sin x}{x} \qquad j_{-1} = \frac{\cos x}{x}$$

The routine for the approximate integration of the differential equation has been successfully programmed by David Howarth of the Solid State and Molecular Theory Group and a program for varying the values of E, ℓ and r and calculating the V_ℓ (E,r) has been written and is being tested.

Howarth

1.3 Operating Statistics

Computer Time

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

Programs	26 hours, 10 minutes
Conversion	11 hours, 47 minutes
Magnetic-Drum Test	04 minutes
Scope Calibration	65 minutes
Demonstrations (#131)	1 hour , 03 minutes
Total Time Used	40 hours, 09 minutes
Total Time Assigned	45 hours, 12 minutes
Usable Time, Percentage	88.85%
Number of Programs Operated	190

1.4 Summary of Tape Room Bulletin Board Memoranda (I. Hazel)

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

Erasing of High-Speed Storage

Erasing of high-speed storage before reading in a 556 tape can now be accomplished by pressing the lower activate button on the panel for intervention registers. The following modes of read-in with erasure are now possible.

1) 556 read-in via the PETR

   (a) press the lower activate button

   (b) press read-in button with tape in the PETR

   Note: If the upper activate button is pressed then si0 must be in the left intervention register.

2) 556 read-in via the Mechanical Tape Reader

   (a) press lower activate button

   (b) press upper activate button with si3 in the left intervention register.

   (c) press read-in button with tape in the mechanical tape reader.

2. COMPUTER ENGINEERING

2.1 WWI System Operation (N.L.Daggett)

On September 14 all power was removed from Electrostatic Storage row. On September 24 the process of dismantling racks EX1 through EX8 was begun. This should bring most welcome relief from the space problem around the Core Memory.

Reliability of the Core Memory has been relatively poor during the last week. There is no indication of any basic difficulty with the cores; it appears that the trouble is entirely in the circuitry associated with them. Unstable write gates in the second bank of core storage have been cured by replacing one Selection Plane Driver Control Switch Panel. A problem of close timing has been found and eliminated: the Memory Address Register was being cleared before the write gates had properly terminated.

A number of failures have occurred in the sensing amplifiers for the Core Memory. As a hedge against further trouble with them, a prototype of the Magnetic Core Memory, Mod. II, sensing amplifier is being tried out.

2.11 Marginal Checking (T. Leary)

Within a week we expect to have each of our marginal-checking test programs arranged to store itself on drum Group 9 immediately following read-in from PETR. They will also each have a PMC program which is self-contained and does not need the Flexowriter reader for storage of MC line numbers. When applying margins produces program-destroying errors, the test program and PMC program may be recovered from drum Group 9 by starting over at 35 (octal). This will save much time over reading in the program again from PETR; the additional time saved by not using the Flexowriter reader should greatly speed up the marginal-checking routine.

We will be marginal checking the Core Memory and Control on a routine basis within a day or two.

2.12 Flexowriter and Paper Tape (L. H. Norcott)

Modifications to our paper-tape verifiers have been completed, and all three verifiers are now in operation: two in the Barta Building tape room and one in Room 10-212 (Student's Program Preparation Room).

During the past two weeks several FL punches and readers have been torn down for routine inspection and maintenance. Overhaul of our FL typewriters will begin next week.

2.2 Terminal Equipment

2.21 Ferranti PETR (F.E.Irish)

A breadboard circuit consisting of phototelectric tubes followed by cathode followers has been constructed for the purpose of testing the optical system of the Ferranti PETR.

The tests have shown that the signal levels in the various channels when measured with a given phototube are within ±10% of a mean value. The variation in phototube sensitivities, however, completely obscures the variations in signal levels due to the optical system. The selection of the 927 phototubes used had a spread in sensitivities of 2 to 1.

Another quantity which was thought to be of interest is the cross talk between adjacent channels. This was found to be negligible when the phototubes are properly positioned.

2.22 Magnetic Tape Print-Out (E. P. Farnsworth)

A low-pass filter has been added at the input of each channel of the print-out reading amplifier to eliminate the cross talk from computer magnetic-tape switching transients and record pulses into the delayed print-out circuits. These filters are effective because the frequency of the capacitively coupled cross talk is about ten times that of the normal magnetic-tape read-out signals.

2.23 Records of Operation (F. J. Eramo)

The following is an estimate by the computer operators of the usable percentage of assigned operation time and the number of computer errors for the period September 11-24, 1953:

Number of assigned hours	137
Usable percentage of assigned time	89
Usable percentage of assigned time since March, 1951	85
Number of transient errors	40
Number of steady-state errors	8
Number of intermittent errors	9

2.3 Group 65

2.31 Storage Tubes (P. Youtz)

At the end of this next biweekly period any further storage-tube production will be stopped. Four or five 800-series storage tubes will be constructed this next period.

The storage-tube work will be cleared out of certain areas and this space can be assigned to other groups.

3. LIBRARY ACCESSIONS LIST

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

Library Files

No.	Source	Title
2526	Repr. PROC.ROYAL SOC. EDINB., v. 63	On the Factorization of Polynomials by Iterative Methods
2529	Ballistic Rsch. Lab.	Random Number Generation on the BRL High-Speed Computing Machines
2531	Raytheon Co.	General Description of the RAYDAC
2532	ONR/Washington	Symposium on Managerial Aspects of Digital Computer Installations
2537	The Rand Corp.	Introduction to the Theory of Games
2538	The Rand Corp.	The Incomplete Approximator
2540	Lincoln Lab.	Flip-Flop Design with Junction Transistors

Laboratory Files

No.	Author	Title
M-2399	H. Neumann	Comparison Between Numerical and Differential Analyzer Methods of Solving Differential Equations
M-2415	S&EC Group	Biweekly Report of 9-6-53
M-2425	G. Young	Digital Techniques for Sorting by Areas in a Plane

4. ADMINISTRATION AND PERSONNEL

New Staff (J. C. Proctor)

Frederick William Sarles, Jr. is working as a Research Assistant assigned to Group 63. He received his B.S. in EE from Duke University this past June.

Jerome P. Stirman is working as a Research Assistant assigned to Group 64. He received his B.S. in EE from the University of Pennsylvania this past June.

Eugene C. Hoy is working as a Research Assistant assigned to Adams' group. He received his B.S. in EE this past June from Tulane University.

David L. Bailey is working as a DDL Staff Member assigned to Group 61. He received his M.S. in Elec. Comm. from MIT in 1950 and after graduating worked for Bell Aircraft.

Terminated Staff

David Finkelstein
John Baldridge

New Non-Staff (R.A.Osborne)

Alma Bassett is a new Laboratory Assistant in Group 63.

Nancy Fitts has joined the Print Room as a Senior Clerk.

Jean Grine is a new member of the Drafting Room.

Esther Iovino is A. Falcione's new secretary.

Janet Landis, a special student at MIT, has joined Group 6345 on a part-time basis.

Henry Mogensen is an MIT undergraduate working part time in Group 63.

Terminated Non-Staff

Students:

Andrew Bowen
Kaye Richey
David Sternlight
Milton Toorans

Others:

Mary Bragaw
Cornelia Buckley
Mathew Di Carlo
Gerald Goodman
Sheila Heffernan
Billy Ridener