Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

SUBJECT: BIWEEKLY REPORT, DECEMBER 27, 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 225 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 11 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.

There was a marked decrease in the activity of the group because of the Christmas holidays. One new problem involves the evaluation of the reflection coefficient in a semi-infinite rectangular open wave guide. The theory for this work was developed by Martin Balser in his doctorate thesis (supervised by Prof. H. Levine) for the Physics Department at Harvard University.

The CS Introductory Programming Course was completed during the first week of this biweekly period. This course will be offered again when the number of qualified applicants is considered large enough. In the meantime a set of seminars has been scheduled to discuss advanced programming techniques and pertinent computer developments. These seminars will begin on 8 January; schedules for the first seven meetings are being distributed.

In the past, numbers for tapes prepared in the Digital Computer Laboratory were assigned in sequence. These numbers conveyed no information about the S&EC problem for which the tape was prepared or about the programmer involved. In the future, numbers for S&EC Group tapes will consist of three numbers separated by dashes (the problem number, a number identifying the programmer, and a serial number assigned by the programmer); e.g. TAPE 100-10-7. A more complete description of this tape numbering system is given below in section 1.4.

An attempt is being made to evaluate pertinent statistics relative to the use of WWI time allocated to the S&EC Group and to the task of preparing the tapes to be read in to the computer. These statistics are approximate and are presented in section 1.3 below.

The Seminar on Computing Machine Methods was held on 15 December. D.T. Ross of the Servomechanisms Laboratory described a mistake diagnosis routine that he has developed for the Whirlwind I Computer.

1.2 Programs and Computer Operation

The following summary is included as a guide for interpreting the abbreviations used below. A more detailed description of the terms involved can be found in M-2497.

a. The upper case letter following the problem number has the following significance:
A implies the problem is NOT for academic credit, is UNsponsored.
B implies the problem IS for academic credit, is UNsponsored.
C implies the problem is NOT for academic credit, IS sponsored.
D implies the problem IS for academic credit, IS sponsored.

The absence of a letter indicates that it is an internal S&EC problem.

b. DIC denotes the Division of Industrial Cooperation.
DCL denotes the Digital Computer Laboratory.
CMMC denotes the Committee on Machine Methods of Computation.
DDL denotes the Division of Defense Laboratories.

100. Comprehensive System of Service Routines, developed by the S&EC Group at the Digital Computer Laboratory for the input conversion of suitably prepared punched paper tapes. When so requested, these routines automatically provide a program with suitable programmed arithmetic, cycle-counting, and output facilities.
:DCL Staff: Arden, 8 hours; Combelic, 26 hours; Denman, 22 hours; Frankovich, 30 hours; Hazel, 12 hours; Kopley, 27 hours; Porter, 4 hours; Siegel, 1 hour; WWI 664 minutes

The modification enabling the "new" CS to convert "OCTAL" programs, mentioned in the last biweekly, has been replaced by another in order to make CS "OCTAL" conversions more analogous to Basic "OCTAL" conversions. One change will be made in the Basic conversion program to make the analogy complete, viz. relative addresses will no longer be always decimal, but will be octal in OCTAL programs. Both changes have as yet to be completely tested and will not take effect until the "new" CS is used.

Frankovich

Successful test runs were made using the drum post-mortem subroutines. These routines (e.g., print-out of instructions in WW or interpretive order code with either decimal or octal addresses; number conversion routines with entry points for different combinations of zero suppression--no spaces, no signs, zero suppression--spaces, signs, etc.) are available in CS subroutine form.

From now on, when the PA Post-Mortem is used and there is no PA in storage or pertinent registers have been destroyed by either a programmer's or operator's

error, the PA PM will print out on direct printer:

PA POST MORTEM
NO PA

Hazel

A program which searches for a block of information on magnetic tape was written and operated successfully. It is currently being modified to eliminate the necessity for consecutive block numbers.

A logical error was discovered and corrected in a program to sum check information stored on the magnetic drum.

Arden

The character generator scope calibration program was revised so as to exploit the maximum available scope area. This resulted in obtaining characters which are at least as large as those obtained by point-wise displays.

A test has been made to determine the operating time of the interpreted instructions of the CS computer. A second test is expected to yield the operating time of these instructions using the new CS program.

Kopley

The CS Introductory Programming Course, which will be given during the first two weeks of any month when a sufficient number of qualified students apply, was completed on December 18. Five S&EC staff members participated in giving the lectures.

The first week's lectures were devoted solely to programming with interpreted instructions. The following are some of the topics covered during the second week: WWI code; number systems; floating-point numbers; cycle control; buffer storage; programmed arithmetic; interpretive subroutines; CS conversion; advanced output; auxiliary equipment.

Denman, Kopley, Porter

101.C. Optical Properties of Thin Metal Films on transparent backings are determined and printed out automatically by this program; the input data consist of the observed reflection and transmission coefficients, the index of the backing, the wavelength, and the sample thickness. The program calculates by means of an iterative procedure and prints out the index of refraction and the absorption coefficient of the film, the rate of variation of these constants with reflection and transmission, and the film's conductivity and dielectric constant.
:for Professor L. Harris, Chemistry Department, Dr. A.L. Loeb
:by Dr. A.L. Loeb, (DIC), 12 hours; J. Richmond (DIC), 15 hours
:DCL: WWI, 75 minutes

Another table by Krantkrämer was checked, and coefficients for backing incidence computed to supplement his results.

Some data on gold blocks for the very far infrared with unreliable reflection measurements but with a dielectric constant of about unity were run; some results were obtained but most samples gave alarms.

106.C. MIT Seismic Project is concerned with the development of methods for locating deep reflections from underground strata in seismic prospecting. The basic method is one of prediction by means of an optimum linear operator.
:for Professor P.M. Hurley, Geology and Geophysics; Professor G. Wadsworth, Mathematics Department
:by E.A. Robinson (Res. Assoc.); H. Briscoe, 38 hours; S. Simpson, 50 hours; W. Walsh, 25 hours
:DCL: WWI, 232 minutes

In the last period the group has checked out two new programs. The first is a correlation program using the formula preferred by Wiener for finite data and is designed to be run in conjunction with a spectrum program which is undergoing modification. The second is a "density plot" scope display of two dimensional data as a substitute for contouring.

107.C. (a) Autocorrelation and (b) Fourier Transform, Integral Evaluation. Programs were developed for these operations for the purpose of obtaining power spectra. The problem remains open for people who want to use these programs.
:for J.E. Ward, Project Engineer, Servomechanisms Laboratory
:by D.T. Ross (DIC); Hamilton, 10 hours
:DCL: WWI, 108 minutes

The Fourier Transform program was used in transforming some results of autocorrelations performed last summer for the Massachusetts Memorial Hospital intestinal motility records.

These runs were satisfactory giving results which confirmed our estimates.

113 C. A Stress Analysis of an L-shaped Homogeneous Planar Structure is being made for the case of a concentrated static load. This structure is approximated by a framework of bars which will deform in the same manner as the prototype. This framework is then analyzed using the principles of virtual work and Southwell relaxation techniques. Boundary conditions have been specified for the edge of the framework so that the deformations of the model will conform to the actual deformations of the structure.
:for Professor J.S. Archer, Department of Civil and Sanitary Engineering
:by S. Sydney (Res. Assist. CMMC), 50 hours
:DCL Staff: Kopley, 2 hours; WWI, 232 minutes

It has been necessary to modify the combined program. A new routine has been incorporated into the program that will give intermediate results during the Whirlwind calculations. Testing of the modified program is continuing.

126 C. A Data Reduction Program for use in the Servomechanisms Laboratory is being developed in separate stages to be combined at a later date. The first stage is concerned with devising a program to fit polynomials to arbitrary empirical functions using a least squared error criterion. The procedure makes use of Legendre polynomials and matrix multiplication.

:for J.E. Ward, Servomechanisms Laboratory, DIC No. 7138, AF33(616)2038
:by D.T. Ross (DIC), 20 hours; D. Hamilton, 60 hours; R. Turyn(DIC) 160 hours
:DCL Staff: Denman, 2 hours

The Polynomial Fit program has failed to operate with the new PA. The post-mortem for printing (24,6) numbers from arbitrary drum storage locations is operating successfully; a minor error in the (24,6) print routine has been corrected.

The interpolation program is being tested for roundoff error, and the accuracy of the 4-point and 6-point formulas is being compared for several functions.

Step 1 of the main program has been reconverted with the new PA and is being tested. The sine and cosine subroutines have been modified slightly.

134 C. Numerical Diagonalization Procedure. This program computes the eigenvalues and eigenvectors of a symmetric matrix by a method of successive rotations. The program is available for use in any problem in which this calculation is required.
:for Professor J.C. Slater, Physics Department
:by A. Meckler (DIC)
:DCL: WWI, 133 minutes

The matrices of Professor Slater and Dr. G. F. Koster have been run through successfully. About 200 5 x 5 matrices have been diagonalized.

137 D. Investigation of Atmospheric Turbulence as a noise input to airborne control systems. A stationary random process is assumed so that the methods of generalized harmonic analysis may be used to describe the turbulence components in terms of their power spectral densities.
:for Professor R.C. Seamans, Department of Aeronautical Engineering
:by R.A. Summers (Res. Assist.), 6 hours
:DCL: WWI, 71 minutes

All the required Fourier transforms have been obtained and problem 137 may now be considered to be successfully concluded. A final summary will be included in the coming quarterly report.

140. Summer Session System consists of a conversion program, an interpretive routine, and mistake diagnostic routines stored in WWI. A special mnemonic instruction code has been developed for use with this system thus simulating a computer with characteristics quite different from those of WWI. This Summer Session (SS) computer was developed for the use of students participating in the MIT 1953 summer session course on "Digital Computers and Their Applications". The SS computer is being used in the E.E. Department courses 6.535 and 6.25 and is available to programmers with suitable problems.
:DCL Staff: Combelic, 16 hours; Frankovich, 2 hours; Siegel, 29 hours; WWI, 219 minutes

The revisions discussed in the previous biweekly report have virtually been completed.

Integers and floating-point numbers, expressed in any of the notations described in the notes for Course 6.535, will be treated properly by both the SS conversion program and the instruction rin. Address assignments of the form a5+6| may now be used without causing difficulty during conversion.

Several programs were run during the biweekly period for students in Course 6.25. There was no difficulty encountered in using the computer for these programs.

The statistical study of the automatic post mortems obtained by the student programmers is continuing.

147 C. Energy Bands in Crystals are being studied by finding solutions of the corresponding second order linear differential equation satisfying boundary conditions at the origin. The solutions are found approximately by using the Gauss-Jackson formula for forward integration. The solutions and their first derivatives are to be combined in a sum, the weighting factors being functions of an independent parameter.
:for Professor J.C. Slater, Physics Department, DIC No. 6853
:by Dr. D.J. Howarth (DIC), 16 hours
:DCL Staff: Arden, 4 hours; WWI, 230 minutes

Production work has continued at a fast rate. The determination of the dependence of E on E_o has almost been completed for the potential chosen--ultimately other potentials will also be used.

In order to reduce the unwieldy amount of output, a modification has been included to cause the machine to determine the zeros of the function $F(E_o)$ for a given E, which is the ultimate result required. The routine proceeds by successive linear interpolations to determine a zero to within a prescribed limit of accuracy. The routine has been successfully tested. The incorporation of this into the main program is being carried out at the time of writing.

152 D. Diffusion in an Oxide-Coated Cathode is being studied to determine the effects of combined thermal and electrolytic diffusion that occur in an oxide-coated cathode when current is caused to flow through the cathode.
:for W.B. Nottingham, Physics Department, DIC No. 6345
:by H.B. Frost (Res. Assist., E.E. Dept.), 8 hours
:DCL Staff: Denman, 1 hour; WWI, 198 minutes

During the past two weeks two runs have been extended beyond the 1-hour point in order to check the convergence of the program to known steady-state values. An error of less than 1 part per 1000 is indicated - this is after 2880 cycles with all accumulated truncation errors. One run has been extended to obtain back-diffusion rates after electrolytic diffusion has been stopped.

It is planned to check carefully agreement between experiment and theory before any additional computation is carried out.

156 A. The Evaluation of the Reflection Coefficient in a Semi-Infinite Open Rectangular Wave Guide is obtained approximately by using Fourier transform techniques on the integral equations of the Wiener-Hopf type. The integrals are to be evaluated by the trapezoidal rule.

:for Dr. M. Balser, Lincoln Laboratory, DDL
:by A. Balser (Res. Assist., Columbia Univ.)
:DCL Staff: Porter, 6 hours; WWI, 8 minutes

The computation arose from the problem of determining the (complex) reflection coefficient from the open end of a semi-infinite rectangular wave guide. A similar problem was solved rigorously by Levine and Schwinger for the circular wave guide, but the rectangular guide requires an approximation. The electric field, E(r), may be expressed as

$$E(r) = i\omega\mu \int_S I(r')\, \Gamma(r', r)\, dS \qquad (1)$$

where S is the surface of the guide, I(r) the current in the wall of the guide, and $\Gamma(r', r)$ the dyadic Green's function

$$\Gamma(r', r) = \left(\mathcal{E} - \frac{1}{k^2}\nabla\nabla'\right)\frac{e^{ik|r-r'|}}{4\pi|r-r'|}, \qquad (2)$$

$\mathcal{E}$ is the unit dyadic, k the (free space) propagation constant, and μ the magnetic permeability of the medium.

Equation (1) is exact and the boundary condition

$$n \times E = 0 \qquad (3)$$

provides a pair of integral equations for the two components of I(r) (transverse and longitudinal). In order to provide a form which is amenable to solution, the components of the current are assumed to have the same transverse behavior as those of the dominant mode of the infinite guide.

The resulting integral equations for the longitudinal behavior of the current components are of the Wiener-Hopf type, and are solved by Fourier transforming the equations and noting the asymptotic properties of the analytic functions thus derived. The reflection coefficient, R, is finally expressed in terms of the residues at a pair of poles of the transformed components of I(r), which in turn are expressed in terms of the transforms of the Green's function components. Explicitly,

$$R = N(k)\, \frac{\left(\frac{K}{k} - 1\right) + M(k)\left(\frac{K}{k} + 1\right)}{\left(\frac{K}{k} + 1\right) + M(k)\left(\frac{K}{k} - 1\right)} \qquad (4)$$

where $K = \sqrt{k^2 - \left(\frac{\pi}{a}\right)^2}$ (with a the longer dimension of the guide cross section) is the guide propagation constant,

$$N(k) = \exp\left\{-\frac{iKa}{\pi}\int_{-(ka)^2}^{\infty} \frac{\log K(\alpha)}{\alpha\sqrt{\alpha + (ka)^2}}\, d\alpha\right\}$$

$$M(k) = \exp\left\{\frac{iKa}{\pi}\int_{-(ka)^2}^{\infty} \frac{\log \frac{K(\alpha)}{I(\alpha)}}{(\alpha - \pi^2)\sqrt{\alpha + (ka)^2}}\, d\alpha\right\}$$

The (complex) functions $K(\alpha)$ and $J(\alpha)$ are to be computed for values in the range $\alpha = -30$ to $\alpha = \infty$ (asymptotic forms are available for $\alpha > 100$). These functions are

$$J(\alpha) = 4 \iint_{-\infty}^{\infty} \frac{d\xi\, d\eta}{\xi^2+\eta^2+\alpha-\pi^2} \frac{(1+\cos\xi)(1-\cos\frac{\eta}{2})}{(\xi^2-\pi^2)^2}$$

$$K(\alpha) = \frac{4}{\pi^2}\frac{\alpha-\pi^2}{\alpha} \iint_{-\infty}^{\infty} \frac{d\xi\, d\eta}{\xi^2+\eta^2+\alpha-\pi^2} (1+\cos\xi)(1-\cos\tfrac{\eta}{2}) \left[\frac{\xi^2+\frac{\pi^4}{\alpha-\pi^2}}{(\xi^2-\pi^2)^2}+\frac{1}{\eta^2}\right] \tag{5}$$

One integration of each double integral can be carried out explicitly. Different forms are obtained depending on which integration is done; the different forms are applicable to the computations for different ranges of α.

These forms are as follows:

For $\alpha > 100$,

$$J(\alpha) \sim 2\frac{1-e^{-\frac{\sqrt{\alpha}}{2}}}{\sqrt{\alpha}} + \frac{16\pi}{3}\frac{1}{\alpha^2}$$

$$K(\alpha) \sim \frac{4}{\sqrt{\alpha}} - \frac{2e^{-\frac{\sqrt{\alpha}}{2}}}{\sqrt{\alpha}} - \frac{16}{\pi\alpha} - \frac{\pi^2}{\alpha^{3/2}} + \frac{32\pi}{3\alpha^2} - \frac{\pi^4}{4\alpha^{5/2}}$$

For $\pi^2 < \alpha < 100$,

$$J(\alpha) = 2\frac{1-e^{-\sqrt{\alpha}/2}}{\sqrt{\alpha}} + 8\pi\int_0^{13} dx\, \frac{1-\cos x/2}{(x^2+\alpha)^2} \frac{1+e^{-\sqrt{x^2+\alpha-\pi^2}}}{\sqrt{x^2+\alpha-\pi^2}}$$

$$K(\alpha) = 2\frac{1-e^{-\sqrt{\alpha}/2}}{\sqrt{\alpha}} + \frac{8\alpha}{\pi}\int_0^{15} dx\, \frac{1-\cos x/2}{x^2}\sqrt{x^2+\alpha-\pi^2}\frac{1+e^{-\sqrt{x^2+\alpha-\pi^2}}}{(x^2+\alpha)^2} + \frac{2\alpha}{\pi(15)^4} - \frac{2\alpha^2}{\pi(15)}$$

For $0 \le \alpha < \pi^2$,

$$J_1(\alpha) = \mathrm{Re}\ J(\alpha) = 2\frac{1-e^{-\sqrt{\alpha}}}{\sqrt{\alpha}} - 8\pi\int_0^{\sqrt{\pi^2-\alpha}} dx\,(1-\cos\tfrac{x}{2})\frac{\sin\sqrt{\pi^2-\alpha-x^2}}{\sqrt{\pi^2-\alpha-x^2}}\frac{1}{(x^2+\alpha)^2}$$

$$+ 8\pi\int_{\sqrt{\pi^2-\alpha}+\rho}^{13} dx\,(1-\cos\tfrac{x}{2})\frac{1+e^{-\sqrt{x^2+\alpha-\pi^2}}}{\sqrt{x^2+\alpha-\pi^2}}\frac{1}{(x^2+\alpha)^2} + \frac{16\sqrt{2\rho}}{\pi^3\sqrt[4]{\pi-\alpha}}\left(1-\cos\frac{\sqrt{\pi^2-\alpha}}{2}\right.$$

$$J_2(\alpha) = \mathrm{Im}\ J(\alpha) = 8\pi\int_0^{\sqrt{\pi^2-\alpha}-\rho} dx\,(1-\cos\tfrac{x}{2})\frac{1+\cos\sqrt{\pi^2-\alpha-x^2}}{\sqrt{\pi^2-\alpha-x^2}}\frac{1}{(x^2+\alpha)^2} + \frac{16\sqrt{2\rho}}{\pi^3}\frac{1-\cos\frac{\sqrt{\pi^2-\alpha}}{2}}{\sqrt[4]{\pi^2-\alpha}}$$

$$K_1(\alpha) = 2\frac{1-e^{-\sqrt{\alpha}/2}}{\sqrt{\alpha}} + \frac{8\alpha}{\pi}\int_0^{\sqrt{\pi^2-\alpha}} dx\ \frac{1-\cos x/2}{x^2}\sqrt{\pi^2-\alpha-x^2}\ \frac{\sin\sqrt{\pi^2-\alpha-x^2}}{(x^2+\alpha)^2}$$

$$+\frac{8\alpha}{\pi}\int_{\sqrt{\pi^2-\alpha}}^{15} dx\ \frac{1-\cos x/2}{x^2}\sqrt{x^2+\alpha-\pi^2}\ \frac{1+e^{-\sqrt{x^2+\alpha-\pi^2}}}{(x^2+\alpha)^2} + \frac{2\alpha}{\pi(15)^4} - \frac{2\alpha^2}{\pi(15)^6}$$

$$K_2(\alpha) = -\frac{8\alpha}{\pi}\int_0^{\sqrt{\pi^2-\alpha}} dx\ \frac{1-\cos x/2}{x^2}\sqrt{\pi^2-\alpha-x^2}\ \frac{1+\cos\sqrt{\pi^2-\alpha-x^2}}{(x^2+\alpha)^2}$$

For $\alpha < 0$ (these forms have not yet been developed with proper asymptotic forms)

$$J_1(\alpha) = 8\pi\int_0^{\sqrt{\pi^2-\alpha}} dx\ \frac{1+\cos x}{(x^2-\pi^2)^2}\ \frac{\sin\frac{1}{2}\sqrt{-\alpha+\pi^2-x^2}}{\sqrt{\pi^2-\alpha-x^2}}$$

$$+ 8\pi\int_{\sqrt{\pi^2-\alpha}}^{\infty} dx\ \frac{1+\cos x}{(x^2-\pi^2)^2}\ \frac{1-e^{-\frac{1}{2}\sqrt{x^2+\alpha-\pi^2}}}{\sqrt{x^2+\alpha-\pi^2}}$$

$$J_2(\alpha) = 8\pi\int_0^{\sqrt{\pi^2-\alpha}} dx\ \frac{1+\cos x}{(x^2-\pi^2)^2}\ \frac{1-\cos\frac{1}{2}\sqrt{\pi^2-\alpha-x^2}}{\sqrt{\pi^2-\alpha-x^2}}$$

$$F_1(\alpha) = -\frac{8}{\pi}(\alpha-\pi^2)\int_0^{\sqrt{\pi^2-\alpha}} dx\ \frac{1-\cos x/2}{(x^2+\alpha)x^2}\ \frac{\sin\sqrt{\pi^2-\alpha-x^2}}{\sqrt{\pi^2-\alpha-x^2}}$$

$$F_2(\alpha) = \frac{8}{\pi}(\alpha-\pi^2)\int_0^{\sqrt{\pi^2-\alpha}} dx\ \frac{1-\cos x/2}{(x^2+\alpha)x^2}\ \frac{1+\cos\sqrt{\pi^2-\alpha-x^2}}{\sqrt{\pi^2-\alpha-x^2}}$$

$$K(\alpha) = J(\alpha) + F(\alpha)$$

Three-place accuracy of the results is desired. The integrals are to be evaluated by the trapezoidal rule, i.e. by

$$I \approx \frac{h}{2}\left[f(a)+f(b)\right]+h\left[f_1+f_2+\ldots+f_{n-1}\right]$$

$$\text{where } h=\frac{b-a}{n},\ f(a)=f(0),\ f(b)=f(n),$$

with h = 0.1.

Thus far, the problem has been coded and test run for the range $10 \le \alpha \le 100$ in integral steps, with the limits of integration of the integral being taken at 0 and 15. Hence, a = 0, b = 15; and since h = .1, we have n = 150.

The first result of the test run, i.e. J(10), was correct, while K(10) and all subsequent J(α)'s and K(α)'s fell off too quickly. On checking the program, an error in resetting a running register was discovered. This error has been corrected and the problem will be rerun.

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, 52 minutes
Conversion	10 hours, 39 minutes
Magnetic Drum Test	18 minutes
Magnetic Tape Test	18 minutes
Scope Calibration	41 minutes
Total Time Used	50 hours, 48 minutes
Total Time Assigned	56 hours, 15 minutes
Usable Time, Percentage	89.9%
Number of Programs	225

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 determined 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 70.9%
   - Output 9.0%
2. Computer Time Lost Due to Programmers' Errors
   - Technical 7.7%
   - Logical 2.8%
3. Computer Time Lost Due to Other Difficulties
   - Tape Preparation 3.6%
   - Operator's Errors 0.5%
   - Terminal Equipment Malfunction 1.6%
   - Miscellaneous 3.9%

1.33 Tape Preparation (M. Mackey)

An attempt is being made to obtain some idea of the time expended in the preparation of tapes. During the past biweekly period a check was made on the tapes processed.

Due to the variations in procedures involved we have distinguished among original complete tapes and the following three types: typed modifications - changes of 11 or more registers which must be typed, converted, then attached to the main program or changes which must be made in the body of a Flexowriter tape; manual modifications - changes punched directly in 556 form and attached to a converted tape; combined tapes - which require duplication of two or more complete tapes.

The following information was compiled:

	Complete Tapes	Typed Mods	Manual Mods	Combined Tapes
No. of Tapes	97	28	27	13
No. of Registers	20,113	515	111	
Time Consumed	59 hrs.14 min.	13 hrs.12 min.	3 hrs.12 min.	7 hrs.57 min.

Thus, it may be seen that the average length of an original complete tape is 207 registers requiring 36 minutes to prepare. A typed modification averages 18 registers in length and requires 28 minutes to prepare while Manual Modifications average 5 registers and require 8 minutes for preparation.

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.)

New S&EC Tape Numbering Procedure

Tape numbers for programs to be run on WWI time assigned to the Scientific and Engineering Group will henceforth consist of three numbers

separated by dashes (e.g., TAPE 150-10-3):

1. The FIRST number (e.g. 150) will be the number of the S&EC problem for which the program was written.

2. The SECOND number (e.g. 10) will be the number assigned to the programmer responsible for the given program. Each programmer working with the S&EC Group will be assigned a unique number. Lists will be kept in the Tape Preparation Room and in Barta 109. Any programmer who has not been assigned a number can obtain one from Miss B. Fallon in Barta 109 (Ext. 3764). A programmer will retain his assigned number as long as he is actively programming with the S&EC Group.

3. The THIRD number (e.g. 3) is assigned by the programmer himself for distinguishing his own tapes.

This new tape numbering procedure will not affect tapes numbered in the old way. Modifications and parameters for such tapes may still be requested as before. However, it is expected that all S&EC programmers, when initiating a new tape number, will follow the new procedure.

2. COMPUTER ENGINEERING

2.1 WWI System Operation

(S.H. Dodd)

Efforts of the systems group during the past biweekly period have been largely concentrated on the task of cleaning up odd jobs with an eye to long-range improvement in system reliability and operating speed.

Many of the computer flip-flops are coupled to their loads through condensers, and it is necessary for the computer to pause occasionally to restore the charge on these condensers. The flip-flops in the parity register are being d-c coupled to their gate tubes. This change to d-c coupling will eliminate the need for restoration and will result in a decrease in memory access time.

The auxiliary-drum system has been giving some trouble due to spurious writing between the slots. This was partly due to power failures, but the system seems to be more sensitive than necessary to malfunctions of this type.

A new real-time clock is being installed in the computer room. The new clock will have nineteen digits instead of the present fifteen. There will be provisions for reading out the most-significant or the least-significant-fifteen digits, giving a coarse and a fine time-reference. The new clock will have provisions for marginal checking which should improve reliability of operation.

(N.L. Daggett)

Since no objections have been raised, the slight modification to the cp order suggested by Helwig and Arden (in M-2560) will be installed on the next installation day.

(L.L. Holmes, A.J. Roberts)

A parity-register panel having d-c coupled flip-flop and cathode-follower circuits was installed as digit 1 of the parity register on 12 December. We will install these modified units at the rate of two or four per week depending on the work load of the systems group.

A replacement for the time-pulse-distributor output panel has been ordered. The unit in service has had several phenolic breakdowns due to silver migration between turret lugs. The new unit will probably be ready for service by 1 February.

A timing difficulty on Time Pulse 1 of the bi order was corrected by the addition of a small delay and the modification of our Type II register-driver circuits.

2.11 Magnetic Tape (E.P. Farnsworth)

Two samples of high-output mylar base Audiotape received from Audio Devices,

Inc. have been installed on units 3A and 3B for testing and observation. Results so far indicate performance equal to MMM #120.

The proposal of Group 6345 to connect an FL Flexowriter to magnetic tape Unit 2 has brought understandably little enthusiasm from Group 64. The combination of two complicated mechanical devices subject to appreciable friction for each word processed, each requiring manual manipulation of a recording material, and having many necessary controls and buttons which do not lend themselves to completely automatic control is not an ideal output for a high-speed computer. It is hoped that efforts to speed up delivery of scope-camera output will reduce the load on delayed print-out equipment. It is worth noting, however, that the delayed print-out has been controlled by breadboard equipment since its inception except for a period of about one month, during which the shop-built control-register panel for the old-style Flexowriter was in service, until the changeover to new-style FL equipment was made. The final production FL control-register panel is now nearly ready for installation.

A print-out program alarm circuit has been devised which will detect the presence of more or less than one complete Whirlwind word per magnetic-tape reading cycle. A similar device to detect recorded "illegal" Flexo codes is also being considered.

2.12 Auxiliary Drum System (K.E. McVicar)

We have had trouble with writing between the slots on several occasions during the past biweekly period. The effect of such spurious writing is to give intermittent read-out, and it is thought to be caused chiefly by two factors: (1) There have been several power failures of a type where the supply voltages to the drum are not turned off in the proper sequence. (2) The copper slug in the new head seems to confine the writing flux somewhat more than was the case in the old plastic-mounted head. This fact, along with the smaller writing current used in the new head, decreases the spread of the flux pattern on the drum surface.

Modifications of power-supply control are now being considered to reduce the possibility of spurious writing due to improper sequence of power turn-off. The effect of variations in write-current amplitude and pulse width are being studied to see whether we can reduce the effect of any between-the-slot writing which should occur by adjustment of these parameters.

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

Demurjian has requested that the direct-output punch be modified to permit making short insertions in the tape through manual operation of the typewriter keyboard. We are now completing a panel for the typewriter table which transfers control of the punch to the keyboard only while the operator depresses a push-button.

To prevent overheating of the code magnet coils in our punches, we are modifying the direct-output punch and paper-tape verifiers by inserting 800-ohm resistors in series with each code magnet coil. Farnsworth will make similar modifications on the delayed-output punch.

2.2 Terminal Equipment (R.H. Gould)

A new real-time clock or timing register will be built up of plug-in units and installed in rack E7 in about one month. The register will have 19 binary digits and will have a smallest time increment of 1/15 second as does the present register. The 19 digits will provide a maximum time count of about 9 3/4 hours for use with automatic program logging. The si address now used will read the 15 less significant digits of the timing register to the right 15 digits of the IOR. The present use of the timing register will not be affected. A new si address will read the timing register to the IOR also but will suppress the readout of the 4 least significant digits and read in their place the 4 most significant digits into digits 12 - 15 of the IOR. The unscrambling of the resultant number is easily programmed. WWI circuits and marginal checking will provide increased reliability of the timing register.

3. ADMINISTRATION AND PERSONNEL

New Non-Staff (R.A. Osborne)

Herbert Bello is a new Laboratory Assistant in the 6345 Group.
Donald Bowman is the new messenger boy.

Terminated Non-Staff (R.A. Osborne)

Frank Yates