

Digital Computer Laboratory  
Massachusetts Institute of Technology  
Cambridge 39, Massachusetts

SUBJECT: BIWEEKLY REPORT, NOVEMBER 29, 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 238 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 26 of the problems that have been accepted by the S&EC Group. Progress on 22 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.

No new problems were initiated during this period. Production runs are being carried out on seven problems (#101, optical properties of thin metal films; #109, three-dimensional airplane pursuit-course; #112, solution of an eigenvector equation for the Educational Testing Service; #113, stress analysis of an L-shaped homogeneous planar structure; #134, determination of the eigenvalues and eigenvectors of symmetric matrices; #137, investigation of atmospheric turbulence by generalized harmonic analysis; #147, study of energy bands in crystals).

Professor F. Hildebrand of the MIT Mathematics Department spoke at the Seminar on Computing Machine Methods on November 17. His topic was "Optimum Interpolation" - a group of about 75 interested persons attended.

It is planned to begin the CS introductory programming course on December 7. This is a resumption of a similar course that was given during the past year. A brief description of the course is given below under Problem #100.

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, 12 hours; Best, 40 hours; Demurjian, 19.5 hours; Derman, 10 hours; Frankovich, 20 hours; Hazel, 13 hours; Helwig, 70 hours; Porter, 18 hours; Combelic, 15 hours; WWI, 364 minutes

A few changes were made and tested to improve the form of the Floating Address (Flad) Table for Delayed Print programs. These changes will be incorporated in the Comprehensive System during the next biweekly period.

Two test programs were run to check four of the subroutines (viz., print-out of WW instructions, interpretive instructions, decimal integers, octal integers) for the Drum Post-Mortem program.

Hazel

Further modifications for the Comprehensive System have been tested. These changes which check for some of the common, logical errors in the program being converted will be described in a forthcoming bulletin board memo. The title print program also is undergoing further changes to take into account the new form for tape titles.

Frankovich

It is planned to begin the CS introductory programming course on December 7. This is a special two weeks course given by the S&EC Group and is intended to prepare selected personnel to program problems approved for solution on WWI. CS Manual I will be used as a text in this course. The first eight chapters of this manual will be available for distribution by December 7.

Derman, Kopley, Porter

Two test programs have been written to test the ability of the new PA to handle (24,6) numbers. The first uses every interpretive instruction except the new ics and prints out results at each step as octal numbers.

The second concentrates mainly on imr and idv, trying these orders for a large number of cases and printing out the cases with the largest round-off errors.

Best

Work is continuing on the development of the new version of the comprehensive system which will include a revised version of the (24,6) programmed arithmetic (PA) subroutine. It is planned to leave both the new version of CS and the old one on tape unit 0 for a test period of at least one month. A brief bulletin board memo will be issued immediately defining the new PA.

Helwig

- 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 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), 15 hours; J. Richmond(DIC),15 hours  
 :DCL Staff: Derman, 2 hours; WWI, 27 minutes

The delayed printer modification and the column headings routine now operate successfully. A modification, requiring only four registers, was programmed and tested. This modification converts the  $R(n,k)-T(n,k)$  program into an  $n(R,T)-k(R,T)$  program. This also worked satisfactorily using the delayed printer, and it will be used to examine published data on films with thickness less than  $75\text{\AA}$  for experimental accuracy.

- 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, 36 hours; S. Simpson, 30 hours; W. Walsh, 20 hours  
 :DCL: WWI, 255 minutes

A new prediction program has been tested and used to form prediction errors for 50 linear operators. Thirty-two frequency spectra of seismograms have been computed in the past two weeks.

Further tests of matrix inversion with a WWI subroutine were unsatisfactory and a new programming approach has been started on this problem.

- 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), 30 hours; D. Hamilton, 5 hours  
 :DCL: WWI, 49 minutes

During this period problem 107 was reopened for the purpose of locating and correcting the error in the Fourier Transform Program being used on problem 136. At first it was thought that the errors were due to round-off in the (15,0) recursion formula used to calculate cosine values. Therefore these calculations were changed to (30,0) form, a worthwhile change which is being retained.

The error actually was due to the modification of the Standard Transform Program of problem 107 for use on problem 136. At the time this modification was made it was assumed that the subroutines of the program could be combined at will. Actually, when only Simpson's Rule is used, the product of the function value times the cosine value must be made before the next cosine value is calculated, rather than after. This oversight has been corrected and the negative values of power no longer appear. The Standard Fourier Transform program was corrected in problem 107.

- 108 C. An Interpretive Program is being developed that will accept algebraic equations, differential equations, etc. expressed on Flexowriter punched paper tape in ordinary mathematical notation (within certain limits imposed by the Flexowriter) as input and automatically provide the desired solution.
- :for Dr. J.H.Laning, Jr., Instrumentation Laboratory  
 :by J.H.Laning, Jr.(DIC), N. Zierler(DIC), 40 hours  
 :DCL Staff: Hazel, 1.5 hours; WWI, 63 minutes

About 70% of the time used this period was devoted to a final checkout of the main program. The remainder of the time was spent in debugging the differential-equation-solving subroutine. It is hoped that this subroutine will be made operative in the next biweekly period.

- 109 C. An Airplane Pursuit-Course Program is being developed which will take account of airplane dynamics and projectile ballistics and thus determine an airplane pursuit course in three dimensions. The problem consists essentially of solving 14 simultaneous non-linear differential equations by the Runge-Kutta Method which is of fourth-order accuracy.
- :for Mr. J.B.Feldman, Instrumentation Laboratory  
 :by M.H.Hellman(DIC), 10 hours  
 :DCL Staff: Fränkovich, 1 hour; Porter, 2 hours; WWI, 95 minutes

A successful run for the three-dimensional pursuit course problem was accomplished. A couple of preliminary test runs of about 7 minutes each were made in order to check out the program before attempting a complete run. The complete run required about 75 minutes and covered 540 steps; each step consisted of a 10-foot increment in the Runge-Kutta Method. The results appear satisfactory particularly in regard to the closing of the slant plane triangle and the gravity drop triangle throughout the run.

It is planned to make a two-dimensional pursuit course run using initial conditions comparable to those used in the three-dimensional pursuit course run. This will give a basis of comparison for the accuracy of the solution of the two-dimensional pursuit course method particularly in regard to time of flight.

- 112 C. Lawley's Method of Factor Analysis is applied to a correlation matrix obtained from psychological tests and grades given at the Naval Academy. This requires the solution of a modified eigenvector equation for this matrix and is accomplished by an iteration of Hotelling's method for solving an eigenvector problem.
- :for Dr. F. M. Lord, Educational Testing Service, Princeton, N.J.  
 :DCL Staff: Derman, 3 hours; WWI, 27 minutes

The matrix problem was run again with assumed ranks of 9 and 10 for the correlation matrix. No alarms occurred and these results are now being examined at the Educational Testing Service.

- 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), 60 hours  
 :DCL Staff: Kopley, 2 hours; WWI, 435 minutes

Production runs have been started on one section of the program. Intermediate results have been obtained in the form of 556 punched tapes which can be used directly in subsequent computations. Testing is proceeding on the remaining sections of the program.

- 119 C. Spherical Wave Propagation produced by the sudden release of a spherical distribution of compressed air in the atmosphere is being studied by numerical means. This involves replacing a set of non-linear hyperbolic partial differential equations in 2 independent and 2 dependent variables by a set of difference equations written along characteristics. An iterative procedure is used to solve these equations.  
 :for Professor C.C.Lin, Mathematics Department  
 :by A. Ralston (CMMC), 5 hours  
 :DCL: WWI, 48 minutes

The only run in the past two weeks produced a set of results which checked previous computation.

Most computer work is being suspended for a couple of weeks while a paper on previous results is prepared.

- 120 D. The Aerothermopressor - This problem is concerned with the development of a device for increasing the stagnation pressure of a hot, high velocity gas stream by means of evaporative cooling. The analytical investigation being carried out on Whirlwind I involves the step-by-step solution of seven simultaneous non-linear differential equations which describe the thermodynamic and dynamic behavior of the compressible flow within the Aerothermopressor.  
 :for Professor A. H. Shapiro, Department of Mechanical Engineering  
 :by B.D.Gavril (Res. Assist.), 15 hours  
 :DCL: WWI, 279 minutes

Since last August, when computational work on this problem was temporarily suspended, a report on this investigation in the form of an Sc.D. thesis for the Department of Mechanical Engineering has been in preparation. This thesis, which is nearly completed, has indicated that significant improvement in aerothermopressor performance can be achieved by proper control of the Mach Number during the process. In order to substantiate these conclusions, the computational work was resumed during the current biweekly period and, with the exception of one pending run, has been successfully completed. A resume of this work follows.

The original program, written last April, was modified to include provision for the Flexowriter code in digits 0 through 5 of the accumulator, and several operating conveniences were added. These include a programmed stop character for the delayed printer and a carriage return counter for providing proper spacing on consecutive sheets during typing. The various drum "roll back" routines were retained, and the 556 program tape, which requires about 75 seconds for read in, is automatically recorded on group 3 of the drum immediately following read in.

Two subroutines for controlling the variation of the Mach Number were written, tested, and used for production runs. In this connection, one of these subroutines will be briefly described here to illustrate the flexibility and convenience of the programming procedure for Whirlwind I.

In the original program, the simultaneous solution of the system of differential equations leads to a single governing equation of the form

$$\frac{dM^2}{dx} = \frac{M^2}{1-M^2} \left( f \frac{dA}{dx} + \frac{dg}{dx} \right) \quad (1)$$

where  $f$  and  $dg/dx$  are functions of the state of the stream at section  $x$ . The program was written only for computing  $dM^2/dx$  from Eq. 1 for arbitrary functional relationships  $A = A(x)$  and, in particular, for constant area ducts in which  $dA/dx = 0$ . In the calculations of the current biweekly, however, it was desired to study processes for which the Mach Number is varied in a prescribed manner, given by  $M = M(x)$ . Equation (1) then determines the area as a function of  $x$ ,  $A = A(x)$ . To accomplish this calculation without a major and risky revision of the program, a subroutine based on the following rearrangement of Eq. (1) above was used:

$$\begin{aligned} \frac{dM^2}{dx} &= \frac{M^2}{1-M^2} f \frac{dA}{dx} + \frac{M^2}{1-M^2} \frac{dg}{dx} \\ &= \frac{M^2}{1-M^2} f \frac{dA}{dx} + \left( \frac{dM^2}{dx} \right) \frac{dA}{dx} = 0 \end{aligned}$$

$$\therefore \frac{dA}{dx} = \frac{\frac{dM^2}{dx} - \left( \frac{dM^2}{dx} \right) \frac{dA}{dx} = 0}{f \frac{M^2}{1-M^2}} \quad (2)$$

The original program is followed in every respect, and the derivative  $(dM^2/dx)$  is calculated from Equation(1) in the usual manner. At this point the subroutine is entered, the correct  $dM^2/dx$  computed from the prescribed relation  $M=M(x)$ , and the area variation then computed from Equation (2) above. The main program is then reentered, and the calculations proceed in the customary way.

This subroutine, and a second one which prescribes the temperature difference between the liquid and gas phase as a function of  $x$ , were written as parameters and provide a convenient and valuable alteration in the calculation procedure.

Various functional relationships of the form  $M=M(x)$  were used. The results verified the prediction of improved performance and will be described in the final report. One additional case for a special type of function  $M=M(x)$  is to be computed during the next biweekly, though no additional programming will be done until the completion of the aforementioned report.

123 C. Earth Resistivity measurements are used to calculate the Slichter kernel function which, in special cases, can be analyzed to give the actual distribution of resistivity. The method involves least-square fitting a set of polynomials to the measured surface-potential function and integrating the product of this set and the zero-order Bessel function.

:for P.M. Hurley, Department of Geology and Geophysics, DIC 5-6915  
 :by K. Vozoff (Res. Assist.CMMC), 30 hours  
 :DCL: WWI, 66 minutes

The integration program, T 2698, has been stopping on the calculation of the last of six polynomial coefficients which are used for interpolation on the normalized potential  $(r, \theta)$  curve. The reason is still undetermined.

T 3373, the subprogram calculating  $J_0(\lambda r)$ , is being run to check errors at various values of  $\Delta(\lambda r)$ . Using a  $\Delta$  of .1, it is in error by .003 at  $\lambda r=11$  if the calculation is started at  $\lambda r=2$ . A  $\Delta$  of .01 gives 5 place accuracy (at least) starting from  $\lambda r=0$ .

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, 80 hours  
 :DCL Staff: Combelic, 2 hours; WWI, 123 minutes

The Mistake Diagnosis Routine (MDR) was used to test sections of the Polynomial Fit Program, as previously described. These tests showed that the higher moments calculated by the Polynomial Fit Program diverge because of the fact that the buffer orders of the present Programmed Arithmetic (PA) Routines operate in (30,6) rather than (30,15). This results in "large" zeros which cause the divergence. The new PA being developed by Helwig will be substituted when it is ready.

The Lagrange Interpolation and Post-Mortem programs have failed to work. Testing and modifications continue.

The MDR report has been modified to refer to the new PA routines, but tapes are available for use with the present PA. Tape listings will be left in the Tape Room when the report is released in about two weeks.

132 C. Subroutines for the Numerically Controlled Milling Machine are being revised and tested. The set of subroutines facilitates programming of the computations involved in the preparation of numerical data used to control the milling machine. The subroutines involve routine numerical and logical operations.

:for J.O.McDonough, Servomechanisms Laboratory, DIC Project 6873  
 :by J.H.Runyon(E.E.Res. Assist.), 20 hours  
 :DCL: WWI, 20 minutes

The subroutine for finding series 16 camber line coordinates and slopes was successfully tested. Previous difficulties were caused by failure to specify a preset parameter in a library subroutine.

Two more subroutines were written - a routine for selecting cut lengths for plane curves such that constant tolerance is obtained and a routine for evaluating the first and second derivatives on a series 16 wing section. The latter routine is used by the constant tolerance routine. A program for computing points on asymmetrical series 16 sections was also prepared and is being tested.

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)

:used by H. Kendall

:DCL Staff: Arden, 10.5 hours; Kopley, 2 hours; Porter, .5 hours

Time was lost due to failure to write generalized decimal numbers correctly, a conversion error, an unexplained error in scope output, and the failure of the erase routine.

After eliminating these difficulties, the eigenvalues and eigenvectors of five 14th order matrices were successfully calculated.

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.), 5 hours

:DCL: WWI, 55 minutes

The Fourier transform program of problem 107 has been successfully corrected and several performance requests submitted. It is anticipated that all required transforms can be performed in about 2 hours of computer time. This should complete problem #137.

138 B. Spheroidal Wave Functions are solutions of the scalar Helmholtz equation separated in spheroidal coordinates. A program has been developed for tabulating both the coefficients obtained by expanding the angular solutions of the first kind in associated Legendre functions and the coefficients obtained by expanding the radial solutions of the first kind in spherical Bessel functions. By analytically substituting these expansions in the separated ordinary differential equations, 3-term recursion relations are obtained for the coefficients, and the radial and angular coefficients are found to be simply related. Both sets of coefficients are then determined by applying an iterative procedure to a continued fraction equation derived from one of the 3-term recursion relations. The iteration proceeds until a value of the unknown separation constant of the differential equation which appears in the continued fraction equation is found such that it makes the coefficients compatible with their boundary conditions.

:for Professor P.M.Morse, Physics Department

:by F.J.Corbató(Res. Assist.CMMC), 30 hours; J.D.C.Little(Res.Assist.CMMC), 30 hours

:DCL Staff: Combelic, 1 hour; WWI, 8 minutes

The final program has been partially revised in anticipation of the new CS PA being written by Helwig. An octal delayed print routine has been written for testing purposes.

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: Best, 37 hours; Combelic, 39 hours Rankovich, 6 hours; Hoy, 38.5 hours; Siegel, 43 hours; WWI, 223 minutes

The subroutines for adding a title-display feature to the SS computer have been written and are undergoing final tests. Only minor mistakes remain in the programs, and it is expected that these errors will be corrected and the final version of the routines incorporated into the fourth pass of the SS conversion program before the end of the next biweekly period.

A temporary addition to the fourth pass, for the use of students in course 6.25 only, is being written. This subroutine will automatically produce identifying information and a set of calibrated co-ordinate axes on the oscilloscope superimposed on the curve to be plotted by the student's program.

A mistake in the instruction rin has been detected and will be eliminated.

- 143 D. The Vibrational Frequency Spectrum of a Copper Crystal is to be determined by solving a  $3 \times 3$  secular determinant, each term of which consists of a finite Fourier Series of 12 terms. This equation must be solved for 24,495 different values of the wave-propagation vector.  
:for Professors B.E. Warren and J.C. Slater, Physics Department  
:by E.H. Jacobsen (Res. Assist.), 1 hour; J.D.C. Little (Res. Assist. CMMC), 2 hours  
:DCL : WWI, 56 minutes

The double integration concerned with second order temperature diffuse scattering of X-rays from a thermally vibrating crystal lattice has been successfully completed.

Also a frequency spectrum for the thermally vibrating lattice of  $\alpha$ -iron has been successfully run making use of a simplified program previously developed by John D.C. Little.

Meanwhile, work is progressing on a high speed program for determining the frequency spectrum of a thermally vibrating copper crystal lattice using exact tensor equations rather than the central force approximation employed in Little's program.

- 144 C. Self-Consistent Molecular Orbitals are the optimum choices of linear combinations of atomic orbitals determined through a process described as a self-consistent field approximation. The numerical procedure involves matrix-vector multiplications, vector additions, and matrix diagonalization.  
:for Professor J.C. Slater, Physics Department  
:by Dr. A. Meckler (DDL), 2 hours  
:DCL Staff: Arden, 7.5 hours; Porter, 2 hours; WWI, 28 minutes

An obscure error in the computation of the total energy was found and corrected. The convergence behavior of the routine is now being examined.

- 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), 20 hours  
 :DCL Staff: Arden, 9 hours; Denman, 1 hour; WWI, 123 minutes

The routine to calculate the Spherical Bessel Functions has been tested, made error free, and has been found to give 7-figure accuracy throughout the range required.

The complete program has been assembled, and production work has started. In the interests of short periods of production time, it has been decided to divide the computation into two parts. First the integrations are performed for a set of energies  $E$ , and the results stored on the magnetic drum; the computing time, including output, for one  $E$  is about  $4\frac{1}{4}$  minutes. A routine has been written which will enable the results stored on the drum to be punched out on tape in a form suitable for input during the second part of the problem. This second part involves the computation of a function of two variables  $E$ ,  $E_0$ . The large number of  $E_0$  required can then be divided into ranges to enable shorter single production runs to be used. In this manner, it will be possible to select for a given range of  $E$  the range of  $E_0$  in which interest lies, thus saving considerable computation time.

- 149 C. Digital Methods of Detecting Signal from Noise are being investigated.

A sequence of binary numbers will simulate the message wherein regions of high density of ones are signal regions and those with low density of ones are noise regions. Various methods of detecting the change from one region to another, as well as the length and midpoint of the signal regions are being studied.

:for J.V.Harrington, Lincoln Laboratory  
 :by G.P.Dinneen, Lincoln Laboratory  
 :DCL: WWI, 34 minutes

The two sequential observer detectors and the success run detector were tried for the weak signal case and for two signal intervals. For the short signal interval, the success run detector is more sensitive while the sequential observer with a bias of +4 is more sensitive for the longer signal intervals. A modified sequential observer will be tried during the next period.

- 152 D. Diffusion in an Oxide-Coated Cathode is a program to calculate 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. Department), 30 hours  
 :DCL Staff: Denman, 2 hours; Porter, 2 hours; WWI, 37 minutes

A new program using an improved third-order approximation to the boundary conditions and an improved short routine for square rooting has been written and tested. Unfortunately, various errors have prevented a successful run thus far. Three coding errors, two errors in conversion, and one tape preparation error have been detected, and all known malfunctions have been explained.

1.3 Operating Statistics

Computer Time

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

Programs	41 hours, 53 minutes
Conversion	14 hours, 32 minutes
Magnetic Drum Test	18 minutes
Magnetic Tape Test	40 minutes
Scope Calibration	<u>54 minutes</u>
Total Time Used	58 hours, 17 minutes
Total Time Assigned	63 hours, 50 minutes
Usable Time, Percentage	91.3%
Number of Programs	238

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.)

Planned Changes For CS

Besides the changes in the new (30-j,j) PA of CS, other changes listed below will be incorporated in the near future.

1. The delayed printer will be used as output for the title and floating address (flad) table information instead of the scope camera. The letters CS will automatically precede all title information print-outs. The conventional form for titles may be used as well as "TAPE 100-34-5 JOSEPH GRMPS". Assigned and unassigned flads will be printed out in separate tables: the assigned flads will be in the form "a6=483", and the unassigned flads in the form "g7 at 48,509". Example:

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CS TAPE NO 3004 M7 JOSEPH GRMPS

unassigned flads

z10 at 32, y9 at 33, x8 at 34,43,204

assigned flads

a1=32 a2=40 a7=45 a9=58  
 c1=93 c2=109 c5=82  
 t4=204 t11=309

---

2. CS will convert the new instruction `isc j` ( $j$  an integer) to `isc 2j +` initial address of counter block.

3. The computer will stop and give an alarm when attempting to convert programs that:

(1) overlap the PA or output routines that are being used.

(2) make flad address assignment when the current address indicator is indefinite (see E-516-2).

(3) contain the special word "OCTAL".

4. The cycle count block will be selected by the use of iti, iat, ict, icr, or isc, as well as by the use of c in the program.

Please forward any suggestions to J.M.Frankovich, Barta Building, Rm. 212, extension 631.

### 1.5 Library of Subroutines

The following is a list of subroutines available in the S&EC Group Library of Subroutines. The routines are now arranged according to title rather than by tape number. Mod numbers are not needed since the taperoom will automatically use the latest mod.

(24,6)	Direct Print Generalized Decimal Number	Tape #3313
"	$e^x$	" 3328
"	Sinh x, Cosh x	" 3329
"	$\sqrt{x}$	" 3330 (*3395)
"	Sin x, Cos x	" 3332
"	Generalized Decimal Number Scope Layout	" 3323
"	" " " " Delayed Printout	" 3333
(30-j,j)	" " " " " "	" 2756
	Single Length Decimal Integer Scope Layout	" 3322
	Fourth Order Runge Kutta, One Step, 'n' Diff. Eq.	" 2745
	Auxiliary Buffer	" 2767
	Largest Eigenvalue	" 3168
	Single Length Decimal Integer Delayed Printer	" 3214
	Simultaneous Equations (Craig's Method)	" 2624
	Format and Delayed Print of Generalized Numbers	" 3217
	Arc Sin x	" 3281

### 1.6 S&EC Library Accessions

The following two books were added to the S&EC Library during the past two weeks.

Handbook of Mathematical Tables and Formulas, Burington, R.S., (B-15)

Mathematical Tables from Handbook of Chemistry and Physics, Hodgman, C.D., (B-16)

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\* Tape #3395 is the new experimental version of the square root routine which is still under test. It is considerably faster than #3330.

2. COMPUTER ENGINEERING

2.1 WWI System Operation

2.11 Core Memory (L. Holmes, A.J.Roberts)

On Monday, November 16, the logic of the block orders bi and bo was revised. One timing problem was encountered that was temporarily corrected with cabling changes. A permanent solution will be placed into effect in the near future.

Also on November 16 the equipment of the computer room proper was modified to include the magnetic drums in the parity-check system. The drum equipment will be ready on Monday, November 23.

Low margins within the pulse generator and the parity register have been corrected. The pulse generator required extensive modifications. The parity-register difficulty was encountered in digit 0 and temporarily corrected by d-c coupling the cathode-follower outputs. Plans are being made to d-c couple the flip-flop and cathode followers of the entire register.

2.12 Auxiliary Drum (K. E. McVicar)

Operation of the auxiliary-drum system has been quite good during the past biweekly period. We have had no reports from operators of any equipment failure during this time.

2.13 Magnetic Tape (E. P. Farnsworth)

Difficulties experienced by the operators with the delayed-output equipment because of errors in some programs are still being blamed on the equipment. A check list and trouble-report form is being made up to insure more precise logging of suspected magnetic-tape-system troubles. This will serve the double purpose of aiding the system technicians in pin-pointing the trouble and giving the magnetic-tape group sufficient information to analyze or reproduce the difficulty.

A Magnicorder reel-drive panel has been adopted for use with Raytheon spline type and triangular-hub reels as well as standard NAB reels to permit convenient filling of reels and transferring of tapes. Machine-shop work done here for the foregoing was so successful that duplicate parts are now being turned out to convert unit 2 to triangular-hub reels at a fraction of the time and cost quoted by Raytheon.

The noise existing in the servo loop of unit 0 which caused small random movement of the reels and slack take-up mechanism has now been shifted to unit 2 by interchanging servo-amplifier chassis. The noise amplitude is now smaller and does not occur until unit 2 has been running for several hours. The trouble will be easier to track down now that it is in the least critical tape unit.

The remaining cross talk which was caused by the MTC unit-select switching transient getting into the delayed-printout system has been cleared up by introducing a 50-microsecond time constant into the unit-select line from IOS. Considerable effort was expended to keep this voltage out of the printout system rather than change the MTC switching circuitry, but slowing down the switching proved to be the only solution.

The occasional reading difficulty experienced with unit 0 during this period was traced by marginal checking to the read-record head. Microscopic investigation of this head revealed contamination by foreign particles; the reading difficulty cleared up after the head was thoroughly cleaned. In addition the problem of head wear, regrinding, polishing, etc., and the effects of this work on the reading-head magnetic air gap are being studied. Microscopic investigation has already produced some significant results.

The problem of head reliability is also being undertaken by B. Paine, who is investigating the apparently inadequate electrical insulation in the Raytheon read/record heads and will take up the problem with the manufacturer.

#### 2.14 Typewriter and Paper Tape (L.H.Norcott)

During the past two weeks we have had several complaints that one of our FL typewriters fails to carriage return properly while printing from magnetic tape. We have not been able to produce this failure in the shop, however, when operating the typewriter either manually or from paper tape. Farnsworth and I will again try this typewriter on magnetic tape in an attempt to track down the cause of this trouble.

#### 2.2 Terminal Equipment (R. H. Gould)

Two new types of film for use with the Fairchild scope camera were tested. They both have better contrast than the film now in use but are so much slower that the frame-counter number is not recorded. The new camera control designed by N.L.Daggett will cure this trouble, and sharper, clearer pictures will be the result.

A method of having fixed-scope gain position and intensity of different values available on a rotary switch is being devised. One setting would be for numbers formed of spots and the other for the smaller, dimmer numbers formed by the character generator. There is some risk of introducing more noise onto the deflection lines, but care will be taken to avoid it.

In-out system troubles in the last two weeks have consisted in part of a loose video cable, power-wiring error, junction-box wiring error, and three timing troubles introduced by changes associated with the drum parity check. Equipment failures have been few.

#### 2.21 Ferranti PETR (J.P.Stirman)

The final breadboard model of the Ferranti Photoelectric Tape Reader has been completed and tested. Its final test in WWI will be delayed until the associated equipment can be constructed and the existing circuits modified.

The tests consisted of plotting the output levels of each channel with the tube voltage as a variable. In this way the marginal performance of the circuit was checked. In addition, the output waveforms were observed on an oscilloscope, with a tape input to the reader. The waveforms indicate that the performance of the unit will be satisfactory although there is no data available as yet on the effects of crosstalk between channels.

4. ADMINISTRATION AND PERSONNEL

Terminated Staff (J.C.Proctor)

Jerome Dintenfass  
Peter Stephan  
Robert Garrett

New Non-Staff (R.A.Osborne)

James Ahlgren is an MIT student working part time in the Transistor Section of Group 62.

Andrew Bowen has returned again to work in the Memory Section of Group 62 on a part-time basis.

Bessie Cachauni is a new messenger girl in the Whittemore Building.

Archie Lemieux has joined the Inspection Department.

Lucy MacFarland has returned to work in the Print Room.

Thomas Murphy is a new member of the Construction Shop.

Anthony Musi is a new member of the Inspection Department.

Terminated Non-Staff (R.A.Osborne)

Mildren Clark  
Gordon Morse