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 Laboratroy.
   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;
     Denman, 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 incor-
porated 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.

                                                        Denman, 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 compre-
hensive 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. <u>Optical Properties of Thin Metal Films</u> 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 <u>Dr. A.L.Loeb</u>,(DIC), 15 hours; J. Richmond(DIC),15 hours
:DCL Staff: Denman, 2 hours; WWI, 27 minutes

The delayed printer modification and the column headings routine now
operate successfully. A modification, requiring only four registers, was pro-
grammed 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 75Å for experimental accuracy.

106 C. <u>MIT Seismic Project</u> is concerned with the development of methods for
locating deep reflections from underground strata in seismic pros-
pecting. 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 <u>E.A.Robinson</u>(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 unsatis-
factory and a new programming approach has been started on this problem.

107 C. <u>(a) Autocorrelation and (b) Fourier Transform, Integral Evaluation.</u>
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 <u>D.T.Ross</u>(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 <u>before</u> the next cosine value is cal-
culated, 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. <u>An Interpretive Program</u> 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),<u>N. Zierler</u>(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. <u>An Airplane Pursuit-Course Program</u> 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: Frankovich, 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. <u>Lawley's Method of Factor Analysis</u> 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: <u>Denman</u>, 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. <u>A Stress Analysis of an L-shaped Homogeneous Planar Structure</u> 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 con-
form 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. Inter-
mediate 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 tempor-
arily 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 pro-
viding 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

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

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:

$$\frac{dM^2}{dx} = \frac{M^2}{1-M^2} f \frac{dA}{dx} + \frac{M^2}{1-M^2} \frac{dg}{dx}$$

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

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

The original program is followed in every respect, and the derivative $\left(dM^2/dx \right)_{dA/dx=0}$ 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. <u>Earth Resistivity</u> 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,ϕ) 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 $\triangle(\lambda r)$. Using a $\triangle$ of .1, it is in error by .003 at λr=11 if the calculation is started at λr=2. A $\triangle$ of .01 gives 5 place accuracy (at least) starting from λr=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 poly-
        nomials 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. <u>Numerical Diagonalization Procedure</u>. This program computes the eigen-
            values and eigenvectors of a symmetric matrix by a method of suc-
            cessive 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 <u>H. Kendall</u>
    :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. <u>Investigation of Atmospheric Turbulence</u> 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 <u>R.A.Summers</u>(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. <u>Spheroidal Wave Functions</u> 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 <u>F.J.Corbató</u>(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. <u>Summer Session System</u> 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 com-
puter 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 Frankovich, 6 hours;
Hoy, 38.5 hours; <u>Siegel</u>, 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 <u>rin</u> has been detected and will be elim-
inated.

143 D. <u>The Vibrational Frequency Spectrum of a Copper Crystal</u> is to be deter-
mined by solving a 3 x 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 <u>double integration</u> 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
$\propto$-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
<u>exact</u> tensor equations rather than the central force approximation employed
in Little's program.

144 C. <u>Self-Consistent Molecular Orbitals</u> 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 approx-
         imately 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 para-
         meter.
         :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 detect-
         ing 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. Unofrtunately, 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	54 minutes
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:

CS TAPE NO 3004 M7 JOSEPH GRMPS

unassigned flads
$z10$ at 32, $y9$ at 33, $x8$ at 34,43,204

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

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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 <u>iti</u>, <u>iat</u>, <u>ict</u>, <u>icr</u>, or <u>isc</u>, as well as by the use of <u>c</u> 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.

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

<u>Mathematical Tables from Handbook of Chemistry and Physics</u>,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 wrok 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