B.C. Dove

1103 USER'S MEETING

ST. FRANCIS HOTEL
SAN FRANCISCO, CALIFORNIA
DECEMBER 1-2, 1955

Aerojet-General Corporation
A & E Building
Sacramento, Calif.
EM 3-3111

✓ Jack C. Van Paddenburg ✓ Dear Jack
Liquid Rocket Plant

Boeing Airplane Co.
Box 3107
Seattle 14, Wash.

R. A. Cole
Pilotless Aircraft Div.
MO 3333 Ext 7565

Donald I. Cook
Physical Research Staff
MO 3333 Ext 7901

J. W. Granholm
Flight Test Operations
Flight Center B-10
MO 3333 Ext 2913

✓ R. E. Porter Dear Randy
Physical Research Staff
MO 7807 Ext 7901

T. C. Wilfong
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MO 3333 Ext 7565

California Research Corporation
P. O. Box 1627
Richmond, Calif.

✓ Douglas C. McGowan Dear Mr. McGowan
BE 2-1514 Ext 457

Eugene B. Reid
BE 2-1514 Ext 592

William J. West
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Digital Computing Lab.
San Diego
California

✓ Ben Ferber
Convair
CY 6-6611 Ext 488

Dear Ben

Edwards Air Force Base

✓ Kenneth C. Rich
Data Reduction Branch
FTFFD
ED 1101 Ext 38171

Dear Mr. Rich

Eglin Air Force Base
Florida

✓ Richard Todd, Commander
Air Force Armament Center
Attn. ACVMC
Eglin AFB 23276

Dear Commander Todd

Holloman Air Development Center

✓ Marvin C. Green
Technical Analysis Div.
Room 372

Dear Mr. Green

Lockheed Missiles

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Van Nuys, Calif.

Werner Leutert
Systems Div.
ST 6-4210 Ext 693

R. B. Talmadge
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Ramo-Wooldridge Corp.

Walter F. Bauer
Los Angeles 95, Calif.

Donn Combelic
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OR 2-0171 Ext 428

Clair E. Miller
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After 12 Dec: California Research Corp.
576 Standard Ave. Richmond, Calif.

Ramo-Wooldridge Corp.
George P. West
8820 Belanca Ave.
Los Angeles 45, Calif.

Telecomputing Corp.
✓ Thomas C. Duke — Dear Tom
128385 Saficoy, Room 371
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POplar 5-8160

White Sands Proving Ground
New Mexico
Mrs. Gray L. Pyle
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✓ Capt. Hugh Wynne — Dear Capt. Wynne
G.G.
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George Eelsel

1103A-UM-00000E

MINUTES OF THE MEETING OF 1103A USERS

AT

THE RAMO-WOOLDRIDGE CORPORATION

Los Angeles, California

19 and 20 December, 1955

As directed by the San Francisco meeting of 1 and 2 December, 1955, a meeting was held on Monday and Tuesday, 19 and 20 December, 1955, at The Ramo-Wooldridge Corporation, Los Angeles, with Dr. Walter F. Bauer acting as chairman.

In attendance were

Boeing Airplane Company
Donald Cook

Holloman Air Force Base
Thomas Duke (Monday only)
Robert Tantzen

Lockheed Missile Systems Division
Bernard Dove (Tuesday only)
Werner Leutert (Monday only)
Richard Talmadge (Tuesday only)

Ramo-Wooldridge Corporation
Walter Bauer
Robert Beach
Donn Combelic
Donald Gantner
Robert Perkins

Sperry-Rand
George Etsell
Jules Mersel

Perkins was appointed to take the minutes of the meeting.

Dr. Eldred C. Nelson, Associate Director of the Computer Systems Division, welcomed the group to Ramo-Wooldridge and expressed the company's interest in cooperation.

The chairman recalled that the San Francisco meeting had agreed on a "Minimum 1103A Installation" to include the following:

Basic 1103A with 4096 words of core storage and Flexowriter output.

Controlled reproducer for punched cards.

Ferranti paper tape reader

Teletype paper tape punch

5 Uniservo magnetic tape units

Off line 600 line/minute printer. (Boeing point plotting modification).

Tantzen pointed out that Holloman is not getting a printer but plans to use magnetic tape output to Uniprinters. This will not hamper their participation in any cooperative scheme, however.

Leutert indicated his willingness to increase his order of five Uniservos if a scheme requiring more should be set up. Boeing has ordered six and Ramo-Wooldridge seven.

Scheduled delivery dates are as follows:

Lockheed	February, 1956
Boeing	March, 1956
Holloman	July, 1956
Ramo-Wooldridge	July, 1956

The chairman also stated that the San Francisco meeting had specified the voting procedure to be used at this meeting: namely, one vote each for Boeing, Holloman, Lockheed, Ramo-Wooldridge, and Sperry-Rand, and one vote for all 1103 users as a group. This procedure was followed throughout the meeting except that no representative of the 1103 Group was present.

The chairman proposed the following agenda drawn up by Ramo-Wooldridge and including suggestions communicated by Boeing:

(1) Definition of membership.

(2) Name of organization.

(3) A brief report from each group of its plans and results to date and its feelings about a cooperative effort.

(4) Procedure for distribution of material.

(5) An exchange language.

(6) Determination of the level of cooperation and participation.

(7) Organizational details and plans for future meetings.

The question was raised as to whether computing center management information such as operating experience, salary policies, etc. should be exchanged. It was decided these items should not be discussed at this meeting, but on a motion by Leutert it was agreed that "one goal is the exchange of management information".

After some discussion of both membership and a name for the organization, it was agreed to postpone decisions on these topics until later in the meeting.

The remainder of the morning and part of the afternoon were devoted to reports from some of the groups present.

SPERRY-RAND reported by Mersel: A tape moving routine has been written, and information on it was distributed at San Francisco. A conversion routine for 1103 programs to 1103A code is almost completed. It is hoped that this will work for 95% of all programs. Leutert suggested that a conversion from 1103A to 1103 might also be needed.

ERA is continuing the Central Exchange. The philosophy adopted has been to require no special language and to do a minimum of editing. This makes it easy to contribute material and to distribute it quickly. ERA has received no complaints about the Central Exchange, except for the time lag. This has been corrected with the institution of the News Flash. There will be an attempt to include some computing center management information in the February issue.

HOLLOMAN - No report at this time.

BOEING reported by Cook: The computing center has three groups, concerned, respectively, with methods, programming, and operation. Currently nine experienced people are working full time in preparation for the 1103A. Three of these have been writing specifications for a compiler, which is ready to be coded. Others have been working on subroutines. Work on input-output has just started.

RAMO-WOOLDRIDGE reported by Combelic: The Computing Center has a total of about 45 people including programmers, hand computers, analysts, and clerical personnel. Of these about seven are in the programming organization group with responsibility for the maintenance and improvement of the present system of sub programs and service routines, and for training new programmers as well as for setting up a system for the 1103A.

The philosophy is that an assembly program or compiler is only part of a computation system. A "black box" system is planned in which the programmer may make all decisions at his desk. A "normal" mode of operation will be established with options provided for deviation from the normal. It is hoped that coding on the system will start February first.

LOCKHEED reported by Leutert: The computers and control section consists of about 30 people in three production programming groups and an operations group, ten in the applied math staff, and ten in the advanced programming group. This latter group has completed specifications for an 1103A plan.

Following this round of reports there was a general informal discussion of what the objectives of the group might be. Among the possible objectives suggested were

1. Exchange of programming techniques and ideas.

2. Exchange of programs and subroutines.

3. Exchange of management information and plans. This might include machine time records, manpower requirements, etc. Possibly some joint recruiting activity.

4. Adoption of a universal programming language for exchanged programs or for actual use at all installations.

5. Adoption of a standard format for program write-ups and descriptions.

6. Adoption of standard subroutine conventions such as location of entrances and exits.

7. Setting up of a cooperative manpower effort.

8. Cooperation at the program planning stage. Consideration of other groups' requirements before writing a program. Possible specialization by each installation on certain types of programs.

No definite action was taken on these suggestions at this time.

The question of membership was again considered. On a motion by Cook, it was decided that "all 1103A users be accorded a vote. A user is an organization which is renting or has purchased or has a firm order for one or more 1103A's". On a motion by Combelic it was agreed that "Sperry-Rand Corporation be accorded one vote".

A motion by Combelic to grant one vote to all 1103 users as a unit was withdrawn after discussion. A motion by Mersel to associate a vote with each 1103A rather than with each organization was defeated.

The meeting recessed until Tuesday morning.

After a brief review of the events of the previous day, it was voted, on a motion by Mersel, that "A purpose of the group is to achieve a uniform general purpose system for the operation of all 1103A's".

The question of a name for the group was re-opened. After a number of straw votes and indications of preference it was decided on a motion by Mersel that "the name of the 1103A cooperative effort be USE, the Univac

Scientific Exchange".

An attempt was next made to set up an organizational framework. After some false starts the following motions were adopted unanimously: (Tantzen left before adjournment and was not present when some of the following votes were taken.)

By Talmadge: "There shall be established a Policy Committee which shall be the governing body of the USE organization. Official participation at Policy Committee meetings shall be by one person from each voting participating member of the USE organization".

By Combelic: "A Standards Committee shall be established consisting of one member from each voting participating organization. The committee shall make recommendations to the USE organization for a computing language common to all participating 1103A organizations".

By Dove: "Boeing shall provide a chairman of the Standards Committee".

By Mersel: "A Publications Committee shall be established. Sperry-Rand shall provide the chairman who shall present a detailed agenda to the first meeting of the Publications Committee".

By Mersel: "A Program Development Committee shall be established. A report (by the chairman) on the problems of, and suggestions for, a common compiler shall be made at the first meeting of the Program Development Committee".

By Cook: "The Program Development Committee shall consist of one member from each USE organization and Donn Combelic of Ramo-Wooldridge shall be chairman".

By Combelic: "The Policy Committee and all other duly established committees shall meet at the same time and location at least once every two months, for not more than two consecutive days. The time and location of each such meeting shall be set by the Policy Committee. Each committee may decide for itself on the time, location, and duration of additional meetings".

By Mersel: "For each meeting of the Policy Committee the host organization shall prepare an agenda in advance, and shall supply a non-voting chairman and a non-voting recording secretary, in addition to its regular voting member".

By Talmadge: "A quorum of the Policy Committee shall consist of at least two-thirds of the member organizations".

By Cook: "At least a two-thirds yes vote and no more than a one-fourth no vote of the members present shall be required to pass a motion in the Policy Committee".

Much discussion was held on the various aspects of the work of the committees and the relations between them. The following items are here included for the record although they were not made official policy or official statement of intent by majority vote:

1. The Policy Committee will review all action taken by the various committees and is enpowered to initiate or veto committee work whenever appropriate.

2. The Standards Committee is responsible for the establishment of standards of communication of programming information. Specific mention is made of the following: form of subroutines, universal language for 1103A programs, flow diagrams, and descriptions of programs.

3. The Program Planning Committee will discuss methods of utilizing programming manpower in a cooperative effort. More specifically, the committee will discuss the programming activities of the member organizations with the aim of channelling certain activities along lines which would be beneficial to all. (A common compiler was mentioned specifically in the motion establishing the committee.)

4. Concern was expressed that there did not seem to be a clear difference in responsibility between the Standards and Program Planning Committees, especially for future activities. Opinion was expressed that sufficient difference

exists to start the work of both committees and that the Policy Committee might re-examine this aspect of the organization.

It was agreed, on a motion by Mersel, that "a meeting of all committees established to date be held on Monday and Tuesday, 9 and 10 January, 1956, in Seattle, with Boeing acting as host".

The meeting was adjourned.

Robert Perkins,

Recording Secretary.

R. Talmadge

MINUTES OF THE MEETING OF USE

AT

BOEING AIRPLANE COMPANY

Seattle, Washington

9 and 10 January 1956

The members of USE (Univac Scientific Exchange) were welcomed to Boeing Airplane Company by Randall E. Porter, Head of the Digital Computing Facility. Mr. Porter acted as chairman during the two-day conference.

In attendance were:

Lockheed Missile Systems Division

B. Handy

Boeing Airplane Company
Donald Cook
August Deckert
Martha Morris
Donald Neilan
Randall Porter
John Stockman
T. C. Wilfong

Ramo-Wooldridge Corporation
Donn Combelic
Donald Gantner
Robert Perkins

Holloman Air Force Base
Robert Tantzen

Sperry-Rand
Thomas Dines
Peggy Johnson
Earl Joseph
Jules Mersel
Jack Rose

The agenda for the USE meetings was presented to each member and explained by the chairman. Prior to a discussion of the definition of committee assignments, Bob Perkins requested that the minutes of the previous meeting be approved. The only discussion concerned a review of the voting procedure and voting members who comprise the Policy Committee. The members of the Policy Committee were:

Ben Handy - Lockheed
Don Cook - Boeing Airplane Company
Don Gantner - Ramo-Wooldridge
Bob Tantzen - Holloman Air Force Base
Jules Mersel - Sperry-Rand

It was moved and seconded that the minutes of the previous meeting be accepted by the Policy Committee as written. This motion was approved unanimously by the Policy Committee.

The first committee listed on the agenda for discussion was the Standards Committee. August Deckert was appointed by Boeing to act as chairman of that committee as directed in the previous minutes. In the discussion of the duties of the committee, Don Cook stated that the Program Development Committee is concerned with what kind of thing to code, while the Standards Committee is concerned with how to code. The Standards Committee would prepare the specifications for a common language, a program write-up, and a minimum assembly program. The group's definitions of assembly program and compiler differ -- assembly program was defined as essentially assembling, on call, library programs while a compiler goes beyond an assembly program. The Standards Committee members were:

Bob Perkins
Earl Joseph
Bob Tantzen
Tom Dines
John Stockman
Gus Deckert - Chairman

The purpose of the Publications Committee was defined next. Dissemination of information to 1103A users is their main goal. They should establish in what form and in what manner and how much information they are willing to publish. It was felt this committee could terminate with the completion of their specifications at this meeting. The Publications Committee members were:

Peggy Johnson - Chairman
Don Neilan
Ted Wilfong

The Program Development Committee would discuss what information is to be exchanged and who would initiate it. In this connection, a definition of a compiler was discussed by Don Cook of Boeing since that company has made the most effort toward a compiler because of the fact that their 1103A computer would arrive so soon.

Don Cook listed the goals of a compiler as:

Translation - Symbolic to Octal

Writing Calling Sequences

Prepare for Input and Output Format

Algebraic Coding

Storage Assignment

Automatic Identification

Scaling

Automatic Post Mortem and Diagnosis

In the time remaining during the morning session, the compiler was explained in more detail by Martha Morris of Boeing. It was decided that the Policy Committee and the Program Development Committee would meet together during the committee meeting periods to further discuss the compiler and programming activities. This group would include:

Donn Combelic - Chairman
Ben Handy
Don Gantner
Jules Mersel
Don Cook
Martha Morris
Jack Rose

The afternoon was devoted to preparation of reports by each committee to be presented to the conference on the following day.

The Policy Committee reconvened at 10:00 A.M. on January 10.

The Chairman of the Standards Committee presented a report of the committee's recommendations. In the discussions that followed, it was pointed out that the recommended language was to be used for the exchange of library programs and was not binding as the language in general use at the particular installations. TRANS-USE, the minimum standard assembly program, was designed to be as simple as possible and, therefore, did not represent any excessive programming burden to any organization.

A motion was made by Ben Handy that the Chairman of the Standards Committee submit to each member in writing a proposal for a common language program and a proposal for a subroutine write-up - the minimum information to be contained and the order in which they are to appear (the sequence of the information). The motion was seconded and Don Cook moved to amend that the proposal also include the subprogram instruction format. The amendment was seconded and passed. The motion was carried as amended.

The Chairman of the Publications Committee presented a report of that committee's recommendations. It was moved by Don Cook that the Chairman of the Publications Committee be appointed the Secretary of the USE Organization. This motion was seconded by Jules Mersel and passed by the Policy Committee. It was pointed out that this is the Executive Secretary, the recording secretary being supplied by the host organization as decided at the preceding meeting.

Following a discussion of the distribution of USE material, Don Cook made a motion that USE material be distributed by the Publications Committee to all 1103 and 1103A Users only. This motion was seconded and carried with one abstention.

Ben Handy moved that material to be submitted to the Publications Committee for distribution be submitted on vellum and that if any other exchange media is desired, the person desiring this information contact the originator of the program. This was seconded by Don Cook and carried.

The Chairman of the Program Development Committee reported that committee's recommendations. It was moved by Ben Handy that the oral report of the Program Development Committee be approved. This motion was seconded by Jules Mersel and approved.

It was suggested that at future meetings consideration might be given to data reduction systems.

Before the conference adjourned, it was decided that the Program Development Committee, the Standards Committee and the Policy Committee would meet on February 16 and 17 in St Paul with ERA acting as host.

Respectfully submitted,

Donald I. Cook
Boeing Airplane Company

Attachment
Oral Committee Reports
presented at this meeting

COMMITTEE REPORTS

Standards Committee

This report was given by the Chairman of the Standards Committee, Gus Deckert. The Standards Committee proposes a TRANS-USE Program as the minimum standard assembly program. It will accept programs written in the standard USE language and translates them to some form directly acceptable by the computer.

The form of the proposed USE language is as follows:

A. Symbol

A symbol consists of from one to six characters, at least one of which must be alphabetic. The characters permitted are the letters of the alphabet, A thru Z, and the numeric digits 0 thru 9. Special significance is attached to the following symbols:

1. The symbol "A" represents the octal number 32000 and refers to the Accumulator.
2. The symbol "Q" represents the octal number 31000 and refers to the Quotient Register.
3. The symbol Dddddd represents the sum of the octal number 40000 and the octal equivalent of the decimal number "ddddd" where "d" is any decimal digit 0 thru 9. This symbol is used for references to the magnetic drum. The decimal number "ddddd" must be less than 16384.
4. The symbol "FILL" in any part of the instruction other than the location (i.e., the operation or either address) indicates that portion of the instructions is to be computed and supplied by the program. If the symbol "FILL" is used as a location, its use there supersedes the above and it will be treated as any other symbol.
5. Symbols F1, F2 and F3 represent actual locations 00000, 00001, and 00002 respectively.

Standards Committee (cont'd)

B. Location

The location of an instruction may be blank or may consist of any one symbol. The symbols are used for reference purposes only and do not, in any way, imply the order of the instructions. The sequence in which the instructions are written specifies the order in which they are to be executed.

C. Operation

The two character mnemonic abbreviations as prepared by ERA are used for basic machine codes except for those commands which require a "j" as a part of the u address. In this case, the "j" is appended to the mnemonic abbreviation as a third character ($0 \leq j \leq 7$). If $j = 0$, it may be omitted if desired.

The operation D indicates a full word decimal constant entered in the u address field.

The operation B indicates a full word octal constant entered in the u address.

D. Addresses

1. Permissible Addresses

   a. References to a location is made by the presence in the address of the symbol corresponding to the location to be referred to.

   b. An invariant address is indicated by entering a decimal number (less than 4096 except for drum references) in the address.

2. Combination Addresses

   In certain instances, it is convenient to express the addresses of a command as a combination of a location and a constant. For this

Standards Committee (cont'd)

purpose, it is permissible to use the two arithmetic operations, add (+) and subtract (-).

E. Program Constants

The operation codes B and D signifies that the u address contains a constant plus sign if necessary. This constant will be converted as a decimal integer if "D" is the operation code and an octal integer if "B" is the operation code.

It is recommended that the programs be transmitted in some directly useable form and include check sums. The actual media of exchange was left to the discretion of the Publications Committee.

No decisions were made relative to the subprogram format.

Publications Committee

This report was presented by Peggy Johnson, Chairman of the Publications Committee. It was decided that only USE material would be published independent of the Central Exchange. USE material would consist of:

1. Minutes of meetings.
2. Solicited information.
3. Operations organizations.
4. Program write-ups.

It was decided that all information submitted to the Publications Committee for distribution should be on vellum. This vellum will then be reproduced and three copies of the material will be furnished each USE participant (two ozalid and 1 sepia). The frequency of distribution will be after each meeting and will include the minutes of the previous meeting (furnished the USE Secretary by the recording secretary) and any accumulated material.

It is the recommendation of the committee that only printed material be exchanged. The facility at St Paul is not able, without considerable inconvenience, to reproduce cards as they do not have a reproducer independent of the 1103. They are able to reproduce punched paper tape and, if it is the wish of USE, will include it as an exchange media.

The Chairman of the Publications Committee requested that the Publications Committee be furnished with the name, address and telephone number of a representative from each organization to whom material is to be sent.

Program Development Committee

This report was presented by Donn Combelic, Chairman of the Committee. The first part of the report was devoted to the determination of how much cooperation can be achieved in the immediate future. The second part was devoted to a discussion of a common compiler.

Common Functions

Ramo-Wooldridge agreed to investigate their function subroutines and Convair's subroutines and evaluate them for USE distribution. ERA agreed to do the same for all other such subroutines, except card routines. At the next meeting of the Program Development Committee, these organizations will present lists of all such routines investigated and recommendations as to which of these subroutines are to be modified for distribution.

Matrix Routines

Don Gantner of Ramo-Wooldridge has agreed to investigate the matrix routines in use at Douglas. Boeing and Lockheed agreed to present a report of their matrix experience at the next meeting of the committee.

Linear Programming

ERA is currently developing a Linear Programming Routine which will be available to USE via the Central Exchange.

Differential Equations

Deferred, inasmuch as there did not seem to be a need for such a program at this time.

Tape Handlers

ERA agreed to distribute information concerning the program "Tape Worm" and also a Tape Boot-Strap for the dead space on the drum.

Program Development Committee (cont'd)

Data Input Routines

This was deferred until such time as a common language was agreed upon. Lockheed agreed to make available the specifications for the input routines of their interpretive system at the next meeting.

Data Output Routines

Boeing agreed to prepare the specifications for fixed point and floating point Data Output Routines of a very simple nature. ERA will prepare the specifications for a generalized output editing routine.

Post Mortems

This was deferred until such time as sufficient information was available as to the post mortem requirements of the USE language.

The second part of the Committee report concerned the problems of a common compiler.

Boeing described their plans for a compiler and some discussion occurred as to the relative merits of the various features. This will be pursued at future meetings.

USE Organization Meeting

January 9 & 10, 1956, Boeing, Seattle

Report of the Program Development Committee

The members of the Program Development Committee are:

Donald Cook, Boeing
Ben Handy, Lockheed
Jules Mersel, Sperry-Rand, St. Paul
Donn Combelic, Ramo-Wooldridge, Chairman

Holloman has not appointed a member to the Committee. In addition to the above members, the following persons attended the committee meetings and participated in the discussions.

Jack Rose, Sperry-Rand, L.A.
Don Gantner, Ramo-Wooldridge
Martha Morris, Boeing

The first meeting of the Program Development Committee was held January 9 from 1:30 to 4:30 P.M. The members discussed how they might cooperate on subroutines. Several classes of subroutines were considered, each in its turn, with the following results.

Common Functions. This term was defined to include subroutines for computing the common transcendental functions, square root, and similar subroutines. There is now a rather extensive library of such routines for use on the 1103--only a few have been prepared specifically for the 1103A. It was agreed by the committee that Ramo-Wooldridge would prepare for consideration by the next meeting an edited list of all such subroutines which are now in the Ramo-Wooldridge library. Sperry-Rand agreed to do the same for the common function subroutines in the ERA St. Paul library. The committee will select subroutines from these lists for inclusion in the USE subroutine library. The work of coding and writing up will be assigned as agreed upon at the February, 1956, meeting.

Matrix Routines. Don Cook of Boeing and Ben Handy of Lockheed said that their organizations had had considerable experience with matrices, but that their personal knowledge of these matters was not extensive. Boeing's open shop arrangement is such that it might be inadvisable for them to develop a set of matrix subroutines for the 1103A. Both Boeing and Lockheed agreed to prepare a report on their organizations' experience with matrices with respect to coding methods, kinds of arithmetic used, accuracy, sizes, etc., so that this information could be used as a basis for the development of subroutines by both individual organizations or on a cooperative basis. Don Gantner of Ramo-Wooldridge mentioned that Douglas Aircraft had had a great deal of experience with matrices and he agreed to collect appropriate information from their organizations, which could then be incorporated into the record of matrix experience for use by the USE organization.

Ordinary Differential Equations. Boeing and Lockheed indicated that their organizations did not feel a need for any differential equation solving subroutines at this time. Ramo-Wooldridge has checked out a Gill method subroutine. It was agreed that planning a cooperative effort on differential equation subroutines would be deferred until a need arose by more than one organization.

Tape Handlers. Lockheed has written some very specialized tape routines for its own use. Considering the other organizations' lack of experience with the 1103A Uniservos, it was felt that no serious attempt should be made to cooperate at this time on writing tape handling routines. Sperry-Rand St. Paul has written two tape routines which may be of general utility: the information about these routines will be distributed to the USE members in the normal course of events. The first routine, known as Tapeworm, moves information between magnetic tapes and core storage. The second is a tape-reading routine which has been coded for execution from the dead space on the 1103A drum. (Incidentally, if members do not have detailed information on the 1103A drum dead space, it can be obtained by writing to Jules Mersel in St. Paul.) There is available a catalogue of UNIVAC tape and utility routines. Sperry-Rand Los Angeles agreed to send a copy of this catalogue to each USE member. The members agreed that they would look through this catalogue with a view to determining what type of routines may be desirable for the 1103A. This kind of knowledge would provide a basis, at the next meeting, for discussion of cooperative coding of tape handlers.

Numerical Data Input. Most of the member organizations are not able at this time to describe their needs for data input subroutines. The only progress along these lines has been made at Lockheed. They have prepared specifications for data input pseudo-instructions which will be part of their interpretive system. The actual coding has not yet been done. However, Lockheed expects to have flow charts prepared (perhaps some coding also) which they will present at the next meeting of the committee. The first of the subroutines is called for in their interpretive scheme by the operation "read floating-decimal tape." The floating-decimal words (48 to a block of magnetic tape) are stored in the form ±xx±xxxxxxxx followed by three spaces. The routine reads and converts the floating-decimal words and stores them in successive memory cells in floating binary. A similar routine will be prepared for octal words 48 per block.

Numerical Data Output. Sperry-Rand has been thinking about a generalized output editing routine similar to that developed for Univac at Livermore and known as the LMO Edit Compiler. The members of the committee agreed that such a routine would be valuable. Sperry-Rand St. Paul agreed to prepare some preliminary specifications for this routine and present them for consideration at the next committee meeting. A generalized editing routine of this type is a very large job and its accomplishment might well require several months. It was agreed that it was most important for each organization to have available within a very short time data output subroutines which would at least print out numbers in some usable form, although this form might not be ideal. Boeing agreed to prepare for the next meeting a set of specifications for two numerical data output subroutines; one to print floating-point numbers; the second to print stated-point numbers. The committee suggested that these subroutines be able to print from zero to eight numbers per line on the high speed printer. The number of numbers to be printed on a line would be controlled by the programmer setting in a parameter just before entering the routine. This parameter would remain in effect then until changed by the programmer. If the detailed specifications as presented by Boeing are approved at the next meeting of the committee, Boeing will code the subroutines.

Diagnostic Routines. Again the lack of experience with the 1103A precluded the members from stating specifically their needs for diagnostic routines. There was general agreement that each organization would want to have at least a selective memory dump and a changed word post-mortem; however, it was felt that their simplicity rendered inadvisable a cooperative effort in coding these particular routines. Ben Handy described Lockheed's plans for a selective tracing routine--considerable interest was shown in this subject and it was agreed that discussion of this type of diagnostic-routine would be listed specifically in the agenda for the next meeting of the Program Development Committee.

Common Compiler. The second Program Development Committee meeting started at 8:30 A.M., January 10, and was devoted to the discussion of the problems of a common compiler. Boeing has made considerable progress in the development of a compiler for the 1103A and they were kind enough to present and discuss in detail the specifications and methods which they are working on. Practically everyone joined in the discussions which ranged from details to general philosophy to be followed. I think it can be said that there was no specific progress made toward developing a common compiler; however, there was considerable airing of the needs of various organizations and in particular how Boeing's plans would either fill, or fail to fill, these needs. It was generally agreed that a great deal of value was gained by each participating organization as a result of these discussions.

Don Cook of Boeing agreed to make at the next meeting an updating progress report on Boeing's compiler, indicating in particular what steps had been taken towards solution of the problems still unresolved at the time of the January meeting. Ramo-Wooldridge said they hoped to have some definite specifications on paper for their compiler by February 1 and would therefore be able and willing to make a presentation in the same spirit as Boeing has made.

Don Cook of Boeing outlined their latest recommendations for the high-speed printer plotting modifications. These specifications are different from those presented at the 1103 Users Meeting at San Francisco in December, 1955. The changes were necessary in order to make consistent the overall input-output printing system. The suggested specifications have not yet been accepted by Sperry-Rand. In the list below the subscripts a, b, c, d, mean left-most, left of center, right of center, right-most, respectively.

Character suggested by Boeing	Original High Speed Printer Character
(	#
)	$
=	%
$\vdash_a$	;
$\dashv_d$	:
$\mid_b$	'
$+_b$	&
$\mid_c$	*
$\mid_d$	(
$+_c$	)
$\mid_a$	+

The Program Development Committee adjourned its meeting at 10:00 A.M., January 10, the second and last day of the USE January meeting.

The remainder of the second day was devoted in part to a presentation by each committee chairman of a report of his committee's actions. In particular, the Program Development Committee chairman gave an oral report which is essentially reproduced above. The next meeting of the Program Development Committee will be held at the same time as the Standards and Policy Committees' meetings at St. Paul, February 16, and 17, with Sperry-Rand acting as hosts.

Donn Combelic, Chairman
Program Development Committee
January 18, 1956

USE CONFERENCE
at
Remington Rand Univac
St. Paul, Minnesota
February 16 & 17, 1956

Thursday February 16

9:15 A.M.	Welcoming Address Conference Room	Byron D. Smith Building 6
9:30 A.M.	Approval of Last Minutes	
	Old Business	Publications
	New Business	

1. Agenda for Program Committee
    - a. CX Subroutine
    - b. Compiler
    - c. Matricer
    - d. Lockheed's Data Input
    - e. Univac Tape Handling

2. Agenda for Standards Committee
    - a. Agree on a Language
    - b. Agree on a Subroutine Format
    - c. Writeup of Subroutines
    - d. Output Routines
        - 1) Boeing
        - 2) Remington Rand Univac

3. Agenda for Publications Committee

12:00 Noon — Lunch at Criterion

1:30 P.M. — Program Planning Committee

Conference Room Building 6

1:30 P.M. — Standards Committee

Conference Room 1164

USE CONFERENCE

Friday February 17

9:00 A.M.	Meet in Conference Room 1164 Leave for Midway YMCA
12:00 Noon	Lunch at YMCA Two Groups
1:00P.M.	One Committee

MINUTES OF THE MEETING OF USE

AT

REMINGTON RAND UNIVAC DIVISION

St. Paul, Minnesota

16 and 17 February 1956

Jules Mersel served as chairman of the meetings. In attendance were:

Boeing Airplane Company

Donald Cook, Policy Committee Member
August Deckert

Holloman Air Force Base

Hans Gschwind
Robert Tantzen, Policy Committee Member

Lockheed Missile Systmes Division

Bernard Dove
Ben Handy
Richard Talmadge, Policy Committee Member

Ramo-Wooldridge Corporation

Donn Combelic
Donald Gantner, Policy Committee Member
Robert Perkins

Remington Rand Univac

Norman Albrecht
Robert Belscamper
Peggy Johnson
Earl Joseph, Policy Committee Member
Jules Mersel
Irvin Voltin

The agenda for the two days of meetings was presented to the group.

Thursday Morning: Policy Committee Meeting

Approval of last minutes
Old Business: Publications
Committee Agendas

1. Program Planning Committee

a. Central Exchange Subroutines

F. 1. Correction (date)
2. Revision of __________ (date)

(If the coding of a routine is corrected, the routine will retain the same index. If the routine is revised in any way, a new index will be assigned.)

(3) The Standards Committee recommended acceptance of the standard subroutine format presented in the proposal from the chairman, with the following revisions:

D.1.b Control data and results need not always be stored within the subroutine. Either the argument or result may be in the Accumulator or Q-Register if this is indicated in the program writeup.

D.1 Preceding the program entry and exits are seven parameter words as follows:

$$\begin{array}{lll} t-7 & n_1 & \text{number of instructions} \\ t-6 & n_2 & \text{number of constants} \\ t-5 & n_3 & \text{number of erasable locations} \\ t-4 & p & \text{number of control items} \\ t-3 & r & \text{number of results} \\ t-2 & s_1 & \rdelim\}{2}{*}[\text{double length check sum}] \\ t-1 & s_2 & \end{array}$$

It was noted that sufficient information is presented here to enable assembly routines to relocate the erasable storage in a common pool.

The Standards Committee suggested that with the USE language now defined it would be appropriate for the Program Development Committee to provide for the writing of specifications for TRANSUSE - the minimum assembly program. After some later discussion it was agreed that the Program Development Committee at the next meeting would try to decide upon what type of output TRANSUSE would provide.

It was also suggested that further consideration be given to the definition of "the standard 1103A". This suggestion arose from discussions within the Standards Committee of the rearrangement of the High Speed Printer type wheels which Boeing intends to make inorder to obtain plotting features. Also, Holloman is contemplating a non-standard plugboard for the Card Unit. Don Cook said that Boeing would send to all USE members a description of their High Speed Printer wheels. All members agreed to send their comments on this rearrangement to Wayne Aamoth, Sales Manager Univac Scientific. It was suggested that in this way it might eventually be decided that the High Speed Printer with plotting facilities is standard equipment.

Two topics for discussion by the Standards Commitee at the next meeting were proposed by the Chairman of the Program Development Committee.

1. Define precisely what is meant by "execution time" of a routine.

2. Reconsider the matter of multiple entries to subroutines.

Bob Perkins
Norm Albrecht
Peg Johnson
Earl Joseph

The Policy Committee reconvened at 1:30 Friday Afternoon.

The chairman of the Standards Committee presented an oral report of the committee's recommendations.

(1) The Standards Committee recommended acceptance of the USE language as described in the proposal distributed by the Chairman of the Standards Committee prior to these meetings with the following revisions and additions. (The numbering refers to the original proposal.)

A.3 Special significance is assigned to the symbol "D" only (D = 40000) rather than the class of symbols Dddddd.

A.6 A special symbol is used to designate octal numbers. Any symbol consisting of from 1 to 5 octal digits followed by the letter B is an octal number.

E. The operation codes "B" and "D" signify that the following word is octal or decimal.

D.1.b An invariant address is indicated by entering a a decimal number of $\leq$ 6 digits in the address.

D.2 An address may be expressed as either a combination of a symbol and a constant or as a combination of two symbols. The two arithmetic operations, add (+) and subtract (-) are used to indicate the combination.

A.4 The symbol "FILL" is translated to the illegal machine address 30000 to provide an immediate stop.

A.5 The symbols F1, F2, and F3 have no special significance. The fixed address F_1, F_2, and F_3 are to be denoted by 0, 1, and 2.

Printing Symbols: All printing symbols are considered to be distinct rather than certain symbols being identified, such as zero and "O", one and "L", two and "Z"

(2) The Standards Committee recommended acceptance of the form for routine writeups prescribed in the proposal from the Chairman with the following additions and revisions:

D.1 The items Calling Sequence, Control Data, and Operational Procedure are separated into three distinct items.

C.4 Number Representation

A.4 Routine Index- a six character index, the first two characters of which designate the orignator.

b. Compiler
c. Matrices
d. Lockheed's Data Input
e. Univac Tape Handling

2. Standards Committee
   a. Agreement on a language
   b. Agreement on a subroutine format
   c. Agreement on writeup of subroutines
   d. Specifications for output routines
      1) Boeing
      2) Rem-Rand Univac

3. Publications Committee

Thursday Afternoon: Committee Meetings

Friday Morning: Committee Meetings

Friday Afternoon: Policy Committee Meeting: Presentation of Committee reports to Policy Committee

The minutes of the previous meeting were accepted. Donn Combelic suggested that the matter of reports from committee chairmen should be clarified. After some discussion it was decided that each committee chairman shall prepare a written report for distribution with the minutes of the Policy Committee meetings. These reports are to be sent to the Chairman of the Publications Committee within two weeks following any meeting. The minutes of the Policy Committee will contain summaries of committee reports made orally to the Policy Committee.

Copies of a Central Exchange release on the formation of USE and a "Summary of USE Publishing Procrdures" were distributed. (A revised version of the latter is appended to these minutes.)

The agendas for the committee meetings were revised to include Output Routines on the agenda for the Program Planning Committee rather than the Standards Committee. It was agreed that there was no business for the Publications Committee. The revised agenda was approved and the joint meeting adjourned until the following afternoon.

The Program Planning Committee members were:

Donn Combelic, Chairman
Don Cook
Hans Gschwind
Bernard Dove
Dick Talmadge
Don Gantner
Bob Belscamper
Jules Mersel
Irv Voltin

The Standards Commitee Members were:

Gus Deckert, Chairman
Bob Tantzen
Ben Handy

Dick Talmadge moved that the group "tentatively accept the USE language proposed by the Standards Committee". This motion was seconded and carried unanimously. The motion was later reconsidered and defeated. The Chairman of the Policy Committee announced that a vote on acceptance of the proposed USE language is to be the first business at the next meeting.

It was then moved and seconded that the proposed program writeup format be accepted. This motion was carried unanimously. Acceptance of the proposed subroutine form was next moved and seconded. This was also carried unanimously.

The Chairman of the Program Development Committee presented an oral report of the committee's actions.

(1) Common function subroutines: Representatives of Boeing, Ramo-Wooldridge, and Remington Rand agreed to have coded by April 1 a number of the common function subroutines. Lockheed agreed to provide some of these subroutines at a later date.

(2) Matrix Routines: Boeing and Ramo-Wooldridge presented reports on experience with matrix routines at their installations (and Douglas-Santa Monica). Don Cook of Boeing agreed to collect more detailed information for the next meeting; Jules Mersel stated that Remington Rand would also report on matrices at that meeting. It was generally agreed that there would be no exchange through USE of matrix routines at the present time. Ramo-Wooldridge distributed copies of the following:

Summary of Douglas Matrix Routines
Linear Matrix Equation Solver (AX=B), MTI-0
Study of Matrix Inversion on the ERA-1103 Employing Routine MTI-0

(3) Numerical Data Input: Boeing described input routines which have already been coded for floating decimal-to-floating binary and for octal numbers. Specifications for a stated point decimal input were given.

(4) Numerical Data Output: Boeing agreed to produce a floating point output routine for the High Speed Printer. The specs for this routine were agreed upon by the Program Development Committee. Boeing also proposed specs for a stated point output routine for the High Speed Printer and will proceed to code this routine. Bob Belscamper presented some remarks on a general output editing routine; it was agreed that Remington Rand would present a set of secifications for such a routine at the next meeting.

(5) Tape Handlers: Jules Mersel described a number of Univac routines which have proved to be useful. Lockheed said that, if possible, they will present at the next meeting their ideas for a general correcting routine and tape diagnostic routines.

There was no discussion of a compiler at this meeting of the Program Development Committee. However, Donn Combelic distributed copies of a Ramo-Wooldridge report: Proposed Translation and Check-Out System for ERA-1103A.

It was moved and seconded that the report of the Program Development

Committee be approved. The motion was carried unanimously.

Dick Talmadge said that Lockheed would be glad to host the next meeting of the Policy Committee. It was decided that this meeting would be held on Thursday and Friday, March 29 and 30 at the Lockheed Missiles Systems Division, Van Nuys, California. The Program Development and Standards Comittees will meet concurrently.

Respectfully submitted

Peggy B. Johnson
Remington Rand Univac

Appendix: Summary of USE Publishing Procedures

PBJ:mlc

A Summary of USE Publishing Procedures

16 February 1956

At the USE meetings in Seattle, January 9 and 10, it was suggested that the chairman of the Publications Commitee prepare a summary of the decisions made concerning the publication of USE material. This summary is presented here.

1. The Publications Committee - The purpose of the USE Publications is to disseminate 1103A information to members of the USE organization. USE material is reproduced and distributed by the Remington Rand Univac Division in St. Paul. All material for publication should be sent to the chairman of the Publications Committee.

   Peggy B. Johnson
   Systems Analysis Department
   Remington Rand Univac Division
   1902 West Minnehaha Avenue
   St. Paul w4, Minnesota

2. USE Publications - Only papers resulting from the USE cooperative effort will be published by USE. 1103A information and routines generated by individual users will be published in the Central Exchange. The USE name on publications will imply compliance with the USE standards as established by the Standards Committee.

   USE publications will include:

   Minutes of meetings
   Solicited information
   Program write-ups

   a. Minutes of Meetings - Within two weeks following each meeting of the Policy Committee, the recording secretary will submit to the Publications Committee chairman minutes of the meeting. Oral reports of the working committees presented to the Policy Committee are to be included in the minutes. Written reports from the committee chairman are to be submitted within the two week period for distribution with the minutes. (Meeting agendas and correspondence of the working committees will be distributed by the committee chairman.)

   b. Solicited Information - The Executive Secretary of USE may, on direction of the Policy Committee, solicit and compile information (e.g. operating procedures and organizations, lists of routines in progress etc.). Such papers will be submitted to the Publications Committee chairman for distribtuion.

   c. Program Write-Ups - Program write-ups will be submitted to the publisher by the members of the Publications Committee representing each of the member organizations of USE. It is the responsibility of such representatives to insure that program write-ups satisfy USE standards.

3. Distribution of USE Publications - USE material will be available to 1103 and 1103A users only. Material relating to the organization of USE and its activities (e.g. minutes of meetings, committee reports) will be sent to the member organizations of USE only. USE products such as 1103A routines, information summaries, and the like will be sent to all 1103 and 1103A installations. USE material will be mailed to the member of the Publications Committee representing the participating organization.

4. Frequency of Distribution - Following each meeting of USE, the minutes and all accumulated material will be distributed.

5. Form of Distribution - Only printed material will be distributed. Three copies of all material will be furnished to each USE participant (two ozalid and one sepia master). One ozalid copy will be sent to each 1103 and 1103A installation.

6. Form of Contribution - All material submitted to the Publications Committee for distribution shall be on vellum.

7. Members of the Publications Committee -

Donald Cook - Boeing Airplane Company
Bernard Dove - Lockheed Missile Systems Division
Donn Combelic - Ramo-Wooldridge Corporation
Robert Tantzen - Holloman Air Force Base
Peggy B. Johnson - Remington Rand Univac

USE Organization Meeting
February 15 and 16, 1956
Sperry-Rand, St. Paul

REPORT OF THE STANDARDS COMMITTEE

The members of the Standards Committee were:

B. Handy, Lockheed Missile Systems Division
Earl Joseph, Sperry-Rand Univac Division
Robert Tantzen, Holloman AFB
Robert Perkins, Ramo-Wooldridge
August Deckert, Boeing (Chairman)
Peggy Johnson, Sperry-Rand Univac Division

The Standards Committee discussed the proposals for a USE language, subprogram format, and subprogram write-up that were mailed to each USE organization after the Seattle meeting. A copy of the final proposals is enclosed.

The identification for subprograms was discussed and a 6 character identification was proposed. The first 2 characters would indicate the organization and the last 4 would indicate the program number. The program number would change whenever a revision was made to the subprogram. The 2 character identification for the present USE members is as follows:

ML	Lockheed Missile Systems Division
RR	Sperry-Rand Univac Division
HO	Holloman AFB
RW	Ramo-Wooldridge
BA	Boeing

Multiple entries and a method for computing running time on subprograms were deferred until the next meeting in Van Nuys.

August Deckert

August Deckert
Chairman, Standards Committee

Enclosure

USE - STANDARDS COMMITTEE PROPOSAL

I. Proposed USE Language

A. Symbol

A symbol consists of from one to six characters, at least one of which must be alphabetic. The characters permitted are the letters of the alphabet, A thru Z, and the numeric digits 0 thru 9. Special significance is attached to the following symbols.

1. The symbol "A" represents the octal number 32000 and refers to the Accumulator.

2. The symbol "Q" represents the octal number 31000 and refers to the Quotient Register.

3. The symbol D represents the octal number 40000 and is used for references to the drum.

4. The symbol dddddB represents the octal number ddddd, where d is any octal digit 0 thru 7. If d equals 8 or 9, it would be noted as a possible error.

5. The symbol "FILL" in any part of the instruction other than location (i.e., the operation or either address) indicates that portion of the instructions is to be computed and supplied by the program. In the u or v address fields, "FILL" will be replaced by 30000. When "FILL" is used as an operation, it will be replaced by "00". If the symbol "FILL" is used as a location, its use there supersedes the above and it will be treated as any other symbol.

B. Location

The location of an instruction may be blank or may consist of any one symbol. The symbols are used for reference purpose only and do not, in any way, imply the order of the instructions. The sequence in which the instructions are written specifies the order in which they are to be executed.

C. Operation

The two character mnemonic abbreviations as prepared by ERA are used for basic machine codes except for those commands which require a "j" as a part of the u address. In this case, the "j" is appended to the mnemonic abbreviation as a third character ($0 \leq j \leq 7$). If $j = 0$, it may be omitted if desired.

The operation D indicates the following full word is a decimal constant.

The operation B indicates the following full word is an octal constant.

D. Addresses

1. Permissible Addresses

a. References to a location is made by the presence in the address of the symbol corresponding to the location to be referred to.

b. An invariant address is indicated by entering a decimal number (less than 32,768) in the address.

2. Combination Addresses

In certain instances, it is convenient to express the addresses of a command as a combination of two locations or a location and a constant. For this purpose, it is permissible to use the two arithmetic operations, add (+) and subtract (-).

E. Program Constants

The operation codes B and D signifies that the following full word contains a constant plus sign if necessary. This constant will be converted as a decimal integer if "D" is the operation code and an octal integer if "B" is the operation code.

USE - STANDARDS COMMITTEE PROPOSAL

I. Proposed USE Program Write-Up Form

   A. Identification

      1. Title

      2. Author - Date

      3. Installation

   B. Purpose - brief statement

   C. Method

      1. Accuracy

      2. Range

      3. Derivation or Reference

   D. Usage

      1. Calling Sequence

      2. Control Data

      3. Operational Procedure

      4. Space Required

      5. Error Codes (left in Accumulator or Q Register)

      6. Format Received or Generated if an Input-Output Routine

   E. Restrictions

      1. Components Required other than "Minimum 1103A"

      2. Other Program Required

      3. Data (Quantity, Form, Parameter Ranges, Number Representation)

      4. Card Form, Tape Format

      5. Wiring Diagram or Board Used, if a Print Routine

   F. Coding Information

      1. Constants and their Locations

      2. Erasable Input-Output Locations

      3. Timing

USE - STANDARDS COMMITTEE PROPOSAL

I. Proposed USE Subprogram Conventions

A. Control Data and Program Results

1. Control data is to be prestored in consecutive locations beginning with location t+3.

2. The program results are to be stored in consecutive locations beginning with location t+3+j, where j is the number of words occupied by the control data, the program can leave an item in the Accumulator, this information would be found in the program write-up.

3. The Accumulator can be used to store one item of control data or results and this should be indicated in the write-up.

B. Program Entry

1. The calling sequence necessary to initiate entry to a subprogram is:

LOC.	OP.	u ADDRESS	v ADDRESS	EXPLANATION
r	RJ	t+2	t	Jump to the first word of the program.
r+1				Control returned here following successful execution of the program.

2. Only one entry (at the starting location) is to be provided. Multiple function programs will include an operation code as part of the control data.

C. Program Exits

Each subprogram will have two exits: The first exit in location t+1 is to transfer control to an automatic diagnostic routine following detection of an error; the second exit in location t+2 is to return control to location r+1 of the calling sequence execution of the subprogram. In the case of an error, a code is to be left in the Accumulator at the time control is transferred to the diagnostic to indicate the type of error and the subprogram in which the error was detected.

D. Subprogram Format

1. The pieces of each subprogram are assembled in the following sequence:

a. Program entry and exits.

b. Control data and program results.

c. The body of the program.

d. The program constants.

e. The erasable storage.

2. The written instructions for a. and b. will appear as follows:

LOC.	OP.	u ADDRESS	v ADDRESS	EXPLANATION
t	MJO	0	START	Jump to the body of the program.
t+1	RJ	DIAG+2	DIAG	Error exit to the diagnostic routine.
t+2	MJO	0	FILL	Success exit to location r+1 of the calling sequence.
t+3	FILL	FILL	FILL	First word of control data.
.				
.				
.				
t+3+j	FILL	FILL	FILL	First word of program results.
.				
.				
.				
START	..	..	..	First word of body of program.

E. Relocation Parameters

A set of parameters needed in the relocation and checking of subprograms will be included with the program. The parameter words will be located before the program entry and exits.

t-7, t-6		double length check sum of the program located at $_8(1000)$.
t-5	n_1	number of cells subject to address modification.
t-4	n_2	number of constants.
t-3	n_3	number of erasable locations.
t-2	p	number of control items.
t-1	r	number of results.

USE - STANDARDS COMMITTEE PROPOSAL

SAMPLE PROGRAM

BA F209, STATED BINARY SQUARE ROOT

AUGUST DECKERT - 16 JANUARY 1956

BOEING AIRPLANE COMPANY

LOCATION	OPERATION	u ADDRESS	v ADDRESS	EXPLANATION
ENTRY	MJ	0	START	Jump to the body of the program.
ERROR	RJ	DIAG+2	DIAG	Error exit to the diagnostic routine.
EXIT	MJ	0	FILL	Success exit to location r+1 of the calling sequence.
Y	FILL	FILL	FILL	$y \cdot 2$ to p
X	FILL	FILL	FILL	$x \cdot 2$ to p+35/2
START	TP	Y	A	Transmit y to Acc.
	SJ	ERROR1	NONEG	y negative
NONEG	TP	A	X	Transmit y to x
	ZJ	NOZERO	EXIT	y equals zero
NOZERO	TP	B	X	Transmit B to x
	EJ	B	EXIT	y equals B
LOOP	SP	Y	35	$y \cdot 2$ to p+35
	DV	X	A	Transmit y/Xn to A
	RS	A	X	y/Xn - Xn to A
	LT	35	Q	$\frac{1}{2}$(y/Xn - Xn) to Q
	RA	X	Q	Xn+1
	QJ	LOOP	EXIT	$\triangle$X negative repeat
ERROR1	SP	CODE1	0	Error code into AR
	MJ	0	ERROR	To error exit
B	B	377777777777		2 to 35 minus 1
CODE1	B	310503150001		F209 x 2 to 12+1

USE - STANDARDS COMMITTEE PROPOSAL

SAMPLE PROGRAM WRITE-UP

1. IDENTIFICATION BA F209, STATED BINARY SQUARE ROOT

   AUGUST DECKERT - 16 JANUARY 1956

   BOEING AIRPLANE COMPANY

2. PURPOSE

   Given y, this program calculates the square root of y.

3. METHOD

   a. This program calculates the square root of y to 34 binary places of accuracy.

   b. The range of y is $0 \leq y \leq 2^{35}-1$.

   c. Newton's iteration method was used to calculate the square roots.

$$Xn+1 = Xn+\frac{1}{2}\left[y/Xn - Xn\right]$$

   when $\frac{1}{2}\left[y/Xn - Xn\right] \geq 0$ iteration is complete

4. USAGE

   a. Calling Sequence

LOC.	OP.	u ADDR.	v ADDR.
r	RJ	t+2	t
r+1	Normal Return		

   b. Control and Results

   The argument y has to be placed at t+3 and the square root of y will be found in t+4 and the Accumulator on return through the success exit.

   c. Space Required

   21 words including constants and working space.

d. Error Codes

These are left in the Accumulator on return through the error exit.

CODE	EXPLANATION
$F209 \cdot 2^{12}+1$	y is negative.

5. RESTRICTIONS

Assume the use of a binary representation as $y \cdot 2^{p}$, then X has binary representation $X \cdot 2^{\frac{p+35}{2}}$. If p is even, a multiplication by the square root of 2 is necessary.

6. CODING INFORMATION

a. Constants

LOCATION	CONSTANT	EXPLANATION
B	377777777777	First approximation for X.
CODE1	310503150001	F209 x 2 to 12+1

b. Working Storage

None.

c. Timing

Unknown.

Dick

USE Organization Meeting

February 16 and 17, 1956, Sperry-Rand, St. Paul

Report of the Program Development Committee

The members of the Program Development Committee are:

Donald Cook, Boeing
Bernard Dove, Lockheed
Jules Mersel, Sperry-Rand, St. Paul
Donn Combelic, Ramo-Wooldridge, Chairman

Holloman has not appointed a member to the Committee. In addition to the above, the following persons attended the Program Development Committee Meetings and participated in the discussions.

Robert Belscamper, Sperry-Rand, St. Paul
Dick Talmadge, Lockheed
Don Gantner, Ramo-Wooldridge
Hans W. Gschwind, Holloman
Irvin Voltin, Sperry-Rand, St. Paul

The Program Development Committee spent most of its meeting time discussing specifications for various subroutines and allocating the necessary work among the members. Several classes of subroutines were considered, with the following results.

COMMON FUNCTIONS - The members agreed to cooperate as indicated in coding the twelve common function subroutines listed below. In each case the name of the organization assuming the responsibility for the routine and salient features of the specifications of the routine are given.

1. Exponential Stated Point - Ramo-Wooldridge

   This will be a re-write of the Ramo-Wooldridge subroutine EXP-2. The scaling on both input and output is 2^{35}; the nominal accuracy is 35 bits--actual accuracy is less due to roundoff in the routine.

2. Exponential Floating Point - Ramo-Wooldridge

   This is a rewrite of the Ramo-Wooldridge subroutine EXP-3. Lockheed will also submit their exponential routines at a later time.

3. Logarithm Stated Point - Sperry-Rand

   The scaling on both input and output is 2^{35}.

4. Logarithm Floating Point - Sperry-Rand

   Also Lockheed will submit their version of the floating point log subroutine on a deferred basis.

5. Square Root Stated Point - Sperry-Rand

   Both the input and output for this square root routine will be considered as integers.

6. Square Root Floating Point - Sperry-Rand

7. Sine-Cosine Stated Point - Sperry-Rand

   The input to this routine is in radians with scaling 2^{32}. Scaling on the output is also 2^{32}. The only limitation on the input is that it must fit into the double length accumulator with the scaling indicated.

8. Sine-Cosine Floating Point - Ramo-Wooldridge

   This will be a rewrite of the corresponding routine which now exists in the Ramo-Wooldridge Library.

9. Arcsine-Arccosine Stated Point - Sperry-Rand

   Input scaled 2^{33}, output in radians scaled 2^{33}.

10. Arcsine-Arccosine Floating Point - Sperry-Rand

    Both the floating and stated-point arcsine-arccosine routines will be self-contained; that is, they will require no external square root subroutine.

11. Arctangent Stated Point - Ramo-Wooldridge

    The input is scaled 2^{33}. The output is in radians 2^{33}.

12. Arctangent Floating Point - Ramo-Wooldridge

    Lockheed will also submit their version of the arctangent floating point on a deferred basis.

All the subroutines described above are to be coded in the form agreed upon by the Standards Committee. This form requires, in the case of the combination subroutines involving sine-cosine and their inverse functions, that the mode of operation must be selected by the programmer before entry. He will select this mode by transferring an appropriate parameter word into a prescribed cell within the subroutine. The Program Development Committee has tacitly left the specification of particular parameter words to the discretion of the organization which has agreed to code the routine. Further details of the standard form of a USE subroutine will be found in the report of the Standards Committee.

<u>MATRIX ROUTINES</u> - Cook (BA) submitted to the Program Development Committee a writeup entitled "Summary of Matrix Experience at Boeing". This is a general discussion of Boeing's experience with their particular matrix problems. Gantner (RW) submitted a writeup entitled "Summary of Douglas Matrix Routines". In addition, Gantner submitted a paper prepared by Ramo-Wooldridge entitled "Study of Matrix Inversion on the ERA 1103 Employing Routine MTI-O". The routine indicated employs a variation of the Gauss elimination method of solution of linear systems. The writeup described results achieved in inverting Hilbert matrices of various orders and also inverting the inverse of Hilbert matrices of the same orders. It also described experience with this routine on two other rather well known matrices. Copies of the R-W papers were distributed to the Committee. Copies of Boeing's writeup are attached herewith. Cook (BA) and Mersel (RR) agreed to try to collect more detailed matrix information for submission at the next meeting.

<u>TAPE HANDLERS</u> - Mersel (RR) discussed the seven most useful Univac tape routines. These routines are in two groups: one for making corrections on tape, one for memory dumps. The first group, correction routines, consists of the following four routines.

1. <u>Mark VIII</u>. The basic operation of Mark VIII is to copy a tape or a portion of tape on to another tape. Mark VIII may be used to duplicate a tape, skip through a tape, merge tapes, change the write density on tapes, or make corrections on a tape. All of the operations are controlled manually through supervisory control type-ins.

2. <u>AC2</u>. AC2 performs the same functions as Mark VIII except that AC2 derives its controls automatically from orders on a Unityped tape. After completion, the routine rewinds the instruction tape. AC2 has been found to be the most useful of the correction routines.

3. <u>AC3.</u> This is a single purpose routine for making corrections to tape. The corrections are tape-controlled and may be listed in any desired sequence on the correction tape. Provision is made for making a permanent record of the corrections.

4. <u>AC4.</u> AC4 is similar to AC3, but in addition provides a check on the corrections. Both the new and the old word are entered on the correction tape along with the identifying block and work number. The original word on the tape to be corrected is compared with the original word as written on the correction tape. Unlike AC3 these correction items must be recorded on the control tape in ascending order by block number.

The second group, as reported by Mersel, consists of the following three routines.

1. <u>Tape Comparator</u>. This routine compares the information on two tapes word by word. If any discrepancies are found they may be printed on the output printer or written on a tape in the following form: The word from tape A, the block and word number, and the word from tape B.

2. Code Edit. This routine prepares an edited printout of an instruction tape in a form similar to that used in the original coding. Options are provided for including the date, and appropriate headings on the printout. The output consists of thirty instruction lines per page and the pages are automatically numbered in sequence.

3. Code Analyzer. This routine lists each line of a program in the form: line number, the left half-word, the right half-word, and all references to that line. It also includes references to lines outside the routine itself such as temporary storage. Mersel indicated that of the three routines listed here the code analyzer was by far the most useful.

All the routines discussed above are written up in a summary form in a "Catalogue of Univac System Routines" prepared by Remington-Rand and dated July, 1955.

Lockheed has need for specialized tape routines for their own use and they expect to give a fairly detailed discussion of their diagnostic tape routines at a future USE Meeting.

Numerical Data Input. Lockheed is continuing to make progress on their data input subroutines. The specifications of these routines were discussed in some detail in the committee report dated January 9 and 10. The only change since that time is that floating-decimal words will be stored eight per blockette rather than forty-eight per block as originally proposed. The same change applies to the octal data input subroutine. As Lockheed proposed at the St. Paul meeting, the subroutines will be entered by an RJ instruction--a parameter word is stored after the RJ. The operation part of this parameter word specifies the tape unit, the u-address section specifies the number of words to be read in, the v-address section contains the storage address of the first word. In light of the Standards Committee's recommendation that parameter words be transferred into the subroutine for entry, it is likely that Lockheed will submit a version meeting this modified specification rather than that described above for the parameter word. Lockheed has done some careful thinking on the read-in of stated-point decimal input. Their ideas have not progressed to the point where the specifications can be written up for publication. They did give a preliminary description of some of their ideas on the subject and it appears that their final system may be acceptable to the organization. They will give a further progress report on their stated-point input data subroutine at the next USE meeting.

Numerical Data Output. Cook (BA) presented specifications for a floating point numerical data output subroutine. After some discussion by the members of the committee the following was agreed upon. The subroutine will be entered by an RJ instruction. A parameter word will be provided to the subroutine in the following form: the operation code of the parameter word indicates the number of words (0 - 8) per line of printing, the u-address part gives the number of lines to be printed, the v-address part word gives the storage location of the first word to be printed. The output of this routine is recorded on Unitape, one line of printing per blockette, in a form suitable for printing on a High Speed Printer. The output format assumes a

120 by 120 plug board on the High Speed Printer. Each number occupies twelve character positions: the leftmost column contains the sign of the number (plus signs are not printed), the next eight characters comprise the mantissa with a decimal point assumed at the left, the next character is the sign of the exponent (Plus signs are not printed) followed by two digits for the decimal exponent. Each full number is followed by three spaces. If it is desired to print the exponent preceding the mantissa, 40 (octal) is to be added to the operation code part of the parameter word. A blank line may be achieved by specifying a parameter word which has a zero OP code. The output format discussed here is quite rigid--provision for a second parameter word to allow more control of the output format will be added to a later routine. It was agreed to go ahead with this rather simple output in order to have something available to the member organizations at the earliest possible date.

Stated-Point Numerical Data Output. Boeing submitted specifications for this subroutine. After some discussion the following specifications were agreed upon. The subroutine is to be entered by an RJ instruction. There may be as many as nine parameter words for this subroutine. The first parameter word is formed in the same way as that for the floating point output routine. The operation code contains a number from zero to eight indicating the number of columns per line, the u-address is the number of lines, the v-address is the storage location of the first word to be printed. This parameter word is followed by from zero to eight additional parameter words specifying the scaling of the words, from left to right, to be printed on that line. (If the OP code of the first parameter word is zero, yielding a blank line, additional parameter words are forbidden.) Each of the scaling parameter words consist of two parts: One of the address sections is the binary scaling, a number ranging from 0 to 35; the other address section specifies the number of decimal places to be printed to the right of the decimal point. Which of these is to be the u and v address is to be decided by Boeing on the basis of convenience in coding. The output again is recorded one line of printing per blockette in a format suitable for printing on a high speed printer assuming a 120 by 120 plug board. Each word printed consists of twelve characters including a point, a sign, and ten digits, (plus signs are not printed). Each such number is followed by three spaces. A maximum of eight numbers may be printed on a line. With respect to further editing the remarks given above on this matter for the floating-point output apply to the stated-point output.

Generalized Output Editing Routine. Reported by Bob Belscamper (RR). Preliminary specifications for this routine as outlined by Sperry-Rand are given below.

1. Provision for as many as 14 columns of output on one or two lines.

2. All output printed in stated-point.

3. Provision may be included for putting the powers of 10 above each column as appropriate.

4. Options provided for zero suppression, location of decimal points, plus or minus signs, etc.

5. There may be provision for a title on each page as well as a date--the date would be entered in the Q register before starting the recording.

6. Column headings for each column as desired.

7. The output editing routine will use pseudo-instructions of a semi-mnemonic form--these instructions will be decoded by the editing routine. The parameter words would be of two classes: one to specify those pieces of information which apply to the entire block of printing desired such as format, number of blocks of this format, title, column headings, etc., the second type of parameter word would consist of the aforementioned pseudo-instructions.

Belscamper indicated that these specifications were not in their final form by any means. The committee agreed that so far they sounded acceptable and agreed to defer further discussion of this generalized output editing routine until the specifications have been firmed up. As discussed in the previous Program Development Committee report the generalized output editing routine is a long-range project and it may be several months before it has been completely checked out.

Common Compiler. Boeing gave a brief report on their compiler, indicating some progress and no substantial changes since the January meeting. Ramo-Wooldridge distributed copies of a report, "Proposed Translation and Check-Out System for the 1103A", dated 13 February, 1956. Time did not allow discussion of this report or of any aspects of a Common Compiler.

Miscellaneous. The Program Development Committee requested that the Standards Committee adopt the use of the phrase "stated point" rather than "fixed point". In addition, the Standards Committee is requested to specify what execution times are to be included in the standard subroutine write-up. At present the minimum, maximum and the average time are usually specified. The Standards Committee is requested to provide precise definitions of the execution times which they decide should be included in the USE Subroutine write-up.

Ramo-Wooldridge, Sperry-Rand, and Boeing agreed to have their subroutines in coded form in time for the next meeting of the Program Development Committee. Lockheed will have their input routines ready for check-out by April 15. The next meeting of the Program Development Committee will be held at Lockheed, Van Nuys, March 29 and 30, in conjunction with the meeting of the entire USE Organization.

Donn Combelic, Chairman
Program Development Committee
March 12, 1956

SUMMARY OF MATRIX EXPERIENCE AT BOEING

Prior to the arrival of the 701, a large part of our work was devoted to matrix solutions. These consisted principally of matrix reductions in one form or another. This work was handled on the 604 or the 602A. In addition, we handled some Eigenvector iteration and characteristic polynomial evaluation on the CPC.

This work was transferred to the 701 through the establishment of a series of library programs. Library programs were written which would perform matrix addition or subtraction and a matrix multiplication. The reduction subprogram was set up to solve: 1) Matrix inversion, 2) Simultaneous linear equations, or 3) The determinant of a matrix. An Eigenvector iteration was also included in this initial library. The programs were written using floating point arithmetic exclusively in both real and complex taking advantage of our experience on pre-existing equipment.

These were put to immediate use by the Structural Dynamics Group in the solution of the flutter problem. As to be expected, the increased capacity and speed of the 701 soon led to the solution of larger order matrices than we had first anticipated. The increased amount of time involved and difficulties attending large matrix solutions (i.e., loss of significance, ill-conditioned matrices, etc.) led us to investigate other methods of solution.

Plans were made for a comprehensive matrix abstraction. The outstanding feature of the plan system was a matrix logic independent of the arithmetic system being used (real or complex, etc.). A number of library programs were written for the system and tested. Due to a lack of manpower, the system was never completed.

Simultaneously, the introduction of the B-52 flutter problem introduced problems which were solved only with considerable difficulty. In particular, the Eigenvector iteration of the B-52 dynamics matrix bogged down inasmuch as that matrix always had at least two roots which were theoretically equal. It should be pointed out that, while the roots are theoretically equal, the inherent error of the matrix provides some separation of these roots. Methods for extracting the characteristic polynomial of these matrices were investigated. Each method fell short of the problem requirements - Leppert's method presumed advance knowledge of the roots which was not available, Danielewski's method failed beyond the 6th order due to inherent error. The problem was temporarily resolved by plotting the determinant of the matrix. Considerable effort was spent in developing a matrix iteration which would capitalize on the small amount of separation of the roots. Basically, the method used was similar to roots squaring in that a power of the matrix was used to obtain an initial approximation to the Eigenvector which was then refined by iterating the original matrix using this initial approximation. For well-behaved matrices, it was found that only a very few iteration cycles were required to develop the degree of refinement desired.

At the present time plans are being made for a less ambitious matrix abstraction to be developed for the 701. Plans for this system include some very special matrix functions which are peculiar to the flutter problem, in addition to the normal matrix functions.

Submitted to USE 16 February, 1956

by Don Cook, Boeing

THURSDAY, MARCH 29, 1956

9:00 a.m. POLICY COMMITTEE MEETING

Conference Room A, Hollywood Roosevelt Hotel

TENTATIVE AGENDA

I. Welcoming Address — R. B. Talmadge

II. Introductions

III. Approve Agenda for Policy Committee

IV. Old Business

A. Approval of Minutes of Minneapolis Meeting

B. TRANSUSE Acceptance

C. Discussion of Procedure for distribution of Minutes

V. New Business

12:00 noon LUNCH - Hollywood Roosevelt Hotel

1:30 p.m. WORKING COMMITTEE MEETINGS

I. PROGRAM DEVELOPMENT COMMITTEE

Conference Room A, Hollywood Roosevelt Hotel

A. Minimum Assembly Interpretation

B. Compiler

1. Report by Boeing

2. Report by Ramo-Wooldridge

C. Generalized Print - Edit

1. Report by Remington-Rand

D. Progress Report on Coding Assignments

II. STANDARDS COMMITTEE

Conference Room A, Hollywood Roosevelt Hotel

A. Coding Format for Transmission of Common Language Programs

B. Number Conventions

C. Definition of Execution Time for Subroutines

D. Multiple Entry or not for Subroutines

FRIDAY, MARCH 30, 1956

9:00 a.m.	COMMITTEE MEETINGS
	Conference Rooms A and C, Hollywood Roosevelt Hotel
11:00 a.m.	INIDVIDUAL MEMBERSHIP CAUCUS
12:00 noon	LUNCH at Hollywood Roosevelt Hotel
1:30 p.m.	POLICY COMMITTEE MEETING
	Conference Room A, Hollywood Roosevelt Hotel

I. Reports from Committee Chairmen

II. Suggestions for Agenda of Next Meeting

III. Date and Place of Next Meeting.

MINUTES OF THE MEETING OF USE

AT

LOCKHEED AIRCRAFT CORPORATION
Missile Systems Division
Van Nuys, California

March 29 - 30, 1956

The meetings were held at the Hollywood Roosevelt Hotel. R. B. Talmadge of Lockheed Missile Systems Division served as chairman. In attendance were:

BOEING AIRPLANE COMPANY

D. Cook, Policy Committee Member
A. Deckert

HOLLOMAN AIR FORCE BASE

R. Tantzen, Policy Committee Member

LOCKHEED MISSILE SYSTEMS DIVISION

R. Cianci
T. Dewey
E. Dodge
B. Dove, Policy Committee Member
B. Handy
A. [illegible]odvin
R. Rock
R. Talmadge

RAMO-WOOLDRIDGE CORPORATION

W. Bauer (morning only)
D. Combelic
D. Gantner, Policy Committee Member
S. Knapp
R. Perkins
M. Perstein

REMINGTON RAND UNIVAC

T. Dines
G. Etsell
P. Johnson, Policy Committee Member
E. Joseph
J. Rose
I. Voltin

The tentative agenda for the two days of meetings was discussed by the group. The following changes were made:

IV. OLD BUSINESS

B. Changed from Transuse Acceptance to USE Language Acceptance.

V. NEW BUSINESS (Following items were added.)

A. Procedure for Communicating Machine Modification to Manufacturer.

B. Invitation to Prospective Members. Requirements for Membership.

C. Sub-Committee Assignments.

D. Procedure for Establishing Agenda.

E. Algebraic Coding System.

F. Standard List for Sepia Masters.

Additions to the Standards Committee agenda:

E. Clarification of Subroutine Format.

F. Discussion of Uniform Scaling.

OLD BUSINESS

It was moved by B. Dove and seconded by D. Cook that the minutes of the St. Paul meeting be approved. The motion was passed unanimously by the Policy Committee.

The USE language, as written in the report of the Standards Committee, was unanimously accepted by the Policy Committee.

It was agreed, in order to avoid the delay in the distribution of minutes, that the committee reports be divorced from the minutes. The minutes will include a synopsis of the committee chairmen reports. In addition, it was agreed that within one week after the meeting, the recording secretary will forward the minutes to the Publications Chairman. The Chairman of the Publications Committee was directed to mail the minutes within two weeks to all members. The Publications Chairman stated that, if there were no objections, the minutes would be distributed as follows: one copy to everyone present at the meeting, three copies to each installation and one copy to the head of each installation.

Following the revision of the agenda, B. Dove made a motion that the agenda be approved as stands and in the order in which it was to be discussed. The motion was seconded and approved by the Policy Committee.

NEW BUSINESS

A. Procedure for Communicating Machine Modification to Manufacturer.

Motion by W. Bauer of Ramo-Wooldridge:

"That a customer-manufacturer relations sub-committee be established, consisting generally of members of the Policy Committee, and that this group meet when items of customer-manufacturer relations are placed on the agenda. This sub-committee will prepare a formal letter to be sent to Wayne Aamoth of Remington Rand, stating the conclusions, and to be signed by the representatives of the various computer organizations as members of USE. The sub-committee shall then report to the Policy Committee."

The above motion was carried and, in effect, the following procedure was set forth:

(1) The sub-committee will be established by the Policy Committee.

(2) The sub-committee will discuss the proposed items for feedback.

(3) The sub-committee will draft the letter for the approval of the Policy Committee.

(4) The sub-committee will make recommendations to the Policy Committee.

(5) The Publications Chairman will send the letter to each member organization for signature.

B. Invitation to Prospective Members - Requirements for Membership.

After a discussion on the above subject, D. Combelic made the following motion:

"When an organization fulfills the membership requirements a letter will be sent from the Chairman of the Publications Committee formally inviting them to become a member of the USE organization. If the organization signifies a desire to join the USE organization, they will then be invited to attend the next Policy Committee meeting, at which time their acceptance will be voted upon by the Policy Committee."

The motion was unanimously carried by the Policy Committee.

It was further decided that any invitations suggested by members between meetings would be handled through the Publications Chairman who, in turn, would contact members of the Policy Committee and receive their vote by mail in order to avoid delay in extending the invitation.

W. Bauer moved that any organization not yet qualified for membership be permitted to attend meetings as long as they are interested non-members. This motion was passed unanimously.

A poll was taken of the Policy Committee regarding inviting Wright Field and Applied Physics Laboratory to the next USE meeting. Upon approval, the Chairman of the Publications Committee was directed to invite them.

C. Sub-Committee Assignments

It was ascertained that this was already a function of the Policy Committee.

D. Agenda Preparation

It was noted that this is a function of the host organization. However, it was suggested that it should be mailed prior to the meeting in order for other members to have the opportunity to familiarize themselves with items listed, and to offer suggestions for changes and additions.

D. Gantner suggested installing a permanent chairman in order to bring some kind of guided continuity to the meetings. After debate on this subject, the Policy Committee agreed to meet and decide upon the following issues:

(1) Whether or not there should be a permanent chairman of the Policy Committee.

(2) If so, to define duties.

(3) Consider tenure of office of all committee chairmen.

(4) If necessary, nominate candidates for this office.

E. Algebraic Coding System

Due to limitation of time, this subject was deferred until Friday afternoon, with the understanding that the Program Development Committee might discuss this subject.

F. Standard List for Sepia Masters.

A standard list was determined and approved by the Policy Committee:

(1) Final committee reports in printed form, when approved by the Policy Committee.

(2) Subroutines and program write-ups.

This does not prevent individual organizations from requesting sepia masters for particular items.

The Policy Committee Meeting was adjourned at 1:30 p.m. Thursday until 1:30 p.m. Friday.

Thursday Afternoon: Working Committee Meetings

Friday Morning: Working Committee Meetings

The Policy Committee reconvened at 1:30 p.m. Friday.

PROGRAM DEVELOPMENT COMMITTEE

The oral report was presented by the Chairman, D. Combelic.

A. Common Functions Subroutines.

Progress reports were presented by Remington Rand, Ramo-Wooldridge and Lockheed. All of the routines have been coded or will be completed by the next USE meeting but, all will not have been machine checked. It was decided that no program would be distributed through USE until it has been machine checked. However, member organizations can obtain copies of the original coding.

B. Numerical Data Input.

Lockheed described a variable format card routine which will read floating decimal or stated point numbers. This routine will be available by the next USE meeting. Suggestions were made and Lockheed said they would take them under consideration.

Boeing presented the stated point output routine which conformed to the specifications agreed upon in St. Paul. This program has been simulated on the IBM 701. The floating point version has been temporarily delayed.

C. Tape Handlers.

Lockheed will give an oral report on their progress at the next USE meeting.

D. Generalized Print Edit.

This project has been abandoned by Remington Rand. Ramo-Wooldridge and Lockheed will attempt to draw specifications as to a type of print edit program.

E. Compilers.

Boeing and Ramo-Wooldridge presented reports on their respective compilers. In addition, Ramo-Wooldridge submitted a written progress report.

F. Printer Modification.

This part of the report was presented by D. Cook of Boeing and resulted in the following action from the Policy Committee:

> D. Cook was appointed a committee of one to write the letter which would be sent to each member of the USE organization for signature. The letter would be distributed in accordance with the procedure developed at a previous session of the Policy Committee. A copy of the letter will also appear in the written report from the Chairman of the Program Development Committee.

D. Cook moved that the Program Development Committee Chairman's oral report be accepted by the Policy Committee. The motion was carried unanimously.

STANDARDS COMMITTEE

The oral report was presented by the Chairman, A. Deckert.

A. Multiple Entry.

It was decided to have only a single entry.

B. Coding Format for Transmission of Common Language Program.

It was felt that without a common compiler a general scheme could not be determined.

C. Number of Conventions

Floating point format was discussed and it was agreed that the exponent will follow the mantissa but the exact word formation was not defined.

D. Execution Time for Subroutines.

Each routine will specify a maximum time. Other times are permissible, as additional information, but must be clearly defined as to how they were determined. In cases where a maximum time cannot be determined, an equation such as $Ax + b$ (X = number of loops) will be given.

E. Card Format.

A standard card format was established for minimum assembly interpretation:

Col.	1-6	7-12	13-25	26-38	39-72	73-75	76	77-80
	Loc	Op	U	V	Comments	Seq.	Insert	Identification

F. Discussion of Uniform Scaling.

Because no standard scheme was proposed, this item was deferred.

G. Clarification of Subroutine Format.

(1) Check Sums

Split commands would be used in determining the check sum.

(2) Error Code for Subroutines

No definite proposal was taken under consideration.

Several items under Subprogram Conventions were made explicit. It was also noted that much discussion concerning minimum assembly interpretation took place.

T. Dewey moved that the Standards Committee Chairman's oral report be approved. The motion was passed unanimously.

After lengthy discussion it was agreed that the Policy Committee should defer discussions of items presented in the Committee Chairmen oral reports unless a serious objection existed. If any member of the Policy Committee did not agree with an item in the oral report, he should submit it as an item for the tentative agenda of the next USE meeting.

DATE AND PLACE OF NEXT MEETING

R. Tantzen offered that Holloman Air Force Base would host the next USE meeting on May 21 and 22 at Holloman Air Force Base. D. Cook moved that the next meeting be held at Holloman Air Force Base. The motion was seconded and passed unanimously by the Policy Committee.

SPECIAL POLICY COMMITTEE MEETING REPORT

In order to provide continuity in the USE organization it was felt that a permanent chairman should be appointed. Subsequently, it was decided by the Policy Committee that a permanent chairman should be appointed for a term of one fiscal year, April 1st to March 31st, to provide this continuity through presiding a Policy Committee Meetings and preparing the agenda.

D. Gantner moved that the position of a permanent chairman of the Policy Committee be established and that the term of office be one fiscal year. His duties include the responsibility of the agendas and presiding at USE meetings thus relieving the rotating host of these duties.

D. Cook moved that Lockheed Missile Systems Division be responsible for providing the chairman for the coming fiscal year. The motion was seconded and carried by a vote of 4 - yes, 1 - abstain.

E. Algebraic Coding System

B. Dove moved that the Policy Committee appoint a special working sub-committee to meet Friday evening, March 31, at Ramo-Wooldridge. The sub-committee to be in effect until the next Policy Committee Meeting, and to perform the following functions:

(1) Study the feasability of a common symbolic compiler.

(2) If in agreement on Step (1), take such action as seemed possible.

Motion was seconded and passed unanimously.

A. Deckert, B. Tantzen, D. Combelic, P. Johnson and B. Dove were appointed to the special working sub-committee. Observers were invited to attend. P. Johnson nominated D. Combelic as Chairman. The nomination was seconded and passed by the Policy Committee.

The meeting was adjourned at 4:30 p.m. Friday.

Respectfully submitted,

R B Talmadge

R. B. Talmadge, Presiding Chairman

Prepared by: Anita Goetzman
Recording Secretary

USE ORGANIZATION MEETING

March 29 and 30, 1956, Lockheed Missiles, Van Nuys

Meeting held at Hollywood Roosevelt Hotel, Hollywood, California

Report of the Program Development Committee

The members of the Program Development Committee were:

Donald Cook, BA
Dick Talmadge, ML
Irvin Voltin, RR
Donn Combelic, RW, Chairman

Holloman has not appointed a member to the committee. In addition to the above, the following persons attended the Program Development Committee Meetings and participated in the discussions:

Tom Dewey, ML
Bernard Dove, ML
George Etsell, RR (At BA)
Don Gantner, RW
Peggy Johnson, RR
Millard Perstein, RW
Jack Rose, RR, Los Angeles

The Committee met during the afternoon of the first day and during the morning of the second day of the USE Organization meeting. The first part of the meeting was devoted to hearing progress reports on the work assignments which had been made at previous meetings. These discussions were interspersed with assignments of new work and re-assignments of some unfinished work. The second main subject considered by the Program Development Committee was that of compiling routines. Both Boeing and Ramo-Wooldridge gave rather detailed progress reports on their respective compilers. Most of the remainder of the Program Development Committee meeting was devoted to discussions of the feasibility and desirability of a common compiler for the USE Organization.

COMMON FUNCTIONS - Seven of the twelve common function subroutines were assigned to Sperry-Rand at the previous meeting; the other five were assigned to Ramo-Wooldridge. None of the subroutines submitted by RW have been checked out. At the previous USE Organization meeting in St. Paul Sperry-Rand volunteered to check out USE subroutine on their Serial 9 1103 which has a Left Transmit operation. In order to have subroutines checked out RW has written them up using the RAWOOP language. RW has submitted to Sperry-Rand bi-octal tapes and up-to-date listings of the RAWOOP conversion program. With this program Sperry-Rand will be able to check out those subroutines submitted to USE by RW. Sperry-Rand however, has been able to submit some subroutines at this meeting which have been checked out on the Serial 9 1103--the status of Sperry-Rand subroutines, as well as those of RW are stated in the comments. The following list shows 1) title of the routine 2) name of the organization assigned to do the coding 3) comments and report of progress to date.

1. Exponential Stated and Floating Point - Ramo-Wooldridge

Ramo-Wooldridge has completed the coding and submitted write-ups of both these routines. After Sperry-Rand has checked them in their RAWOOP form on the Serial 9 1103 RW will re-write the coding in the accepted USE language incorporating any changes found necessary during the check out. Therefore, the copies which have been submitted at this meeting by RW are not official final copies for circulation in the USE Organization. Such copies will be forthcoming.

2. Logarithm Stated and Floating Point - Sperry-Rand

Both of these subroutines have been coded but have not yet been checked out. Write-ups will be submitted as soon as the checking out has been completed.

3. Square Root Stated and Floating Point - Sperry-Rand

Both of these subroutines have been coded and checked out. Sperry-Rand submitted a write-up of the stated point square root subroutine.

4. Sine-cosine Stated Point - Sperry-Rand

This subroutine has been coded and checked by Sperry-Rand. A write-up was submitted at the meeting.

5. Sine-Cosine Floating Point - Ramo-Wooldridge

This subroutine has not yet been coded for the 1103A by Ramo-Wooldridge. As soon as it is a copy will be sent to Sperry-Rand for check out on the Serial 9 1103.

6. Arcsine--Arccosine Stated and Floating Point - Sperry-Rand

One of these routines has been coded, the other has not; neither of the routines has been checked. As soon as the check-out has been completed Sperry-Rand will send write-ups to the member organizations.

7. Arctangent Stated and Floating Point - Ramo-Wooldridge

Both of these subroutines have been coded, written up and submitted. Sperry-Rand will check them out on the Serial 9 machine after which RW will submit official copies to the organization. Sperry-Rand also submitted a write-up of a checked out stated point arctangent subroutine which appears to be nearly the same routine as that submitted by RW.

In summary, it appears that the work assignments have been very well carried out by the member organizations and that most of the common function routines will be in their final form and circulated to all the members in the near future.

MATRIX ROUTINES - Voltin (RR) submitted to the Program Development Committee a short report prepared by Professor Marvin Stein, University of Minnesota. This report summarizes matrix methods as used in digital computation and includes several references in the current literature. It should be of value to installations unfamiliar with present day matrix techniques on high speed digital machines. It was agreed by members of the committee to defer exchange of information on matrix methods or routines until further notice.

TAPE HANDLERS - Lockheed seems to have taken the most active interest in producing tape handlers and tape diagnostic routines for their own operation. Because of the press of other matters, the other organizations, as well as Lockheed to a certain extent, have not been able to investigate these matters fully. However, Lockheed expects within the next several weeks to be able to study this problem more thoroughly. After they reach some tentative conclusions on the specifications for routines which they think may be useful, they will describe them at a USE Meeting. There was an informal agreement between Lockheed and RW that if specifications were decided upon, these two organizations might cooperate on the actual coding and checking out of such routines.

NUMERICAL DATA INPUT - Lockheed has completed the coding of a routine for reading and converting floating decimal numbers on magnetic tape. The code as now written will handle variable block input. The form of the numbers as written on the tape is somewhat different from that specified in the past: each number is in the form ±xxxxxxxx±xx followed by three spaces. Thus each floating point number on tape requires fifteen consecutive characters. In the variable block routine a parity check is made and three attempts at different bias levels are made to read the block if the parity check fails. If all the attempts fail, the diagnostic routine is entered. With slight modification the variable block routine can be modified to handle fixed block input. In this case each blockette contains eight floating point decimal numbers in the form previously specified. However, the present version of the routine does not make the parity check when in the fixed block mode, rather a check is made only to see if 720 characters are read. After some discussion, it was agreed that addition of the parity check feature, as it now exists in the variable block routine, would be desirable in the fixed block routine. The conclusion was that Lockheed would modify their fixed block subroutine in this fashion. Because Lockheed has no machine these subroutines have not been checked out. However, they have been coded and written up and because of the considerable interest in coding of this kind, Lockheed has agreed to submit copies to all member organizations.

Lockheed has been devoting considerable effort to developing specifications for a generalized card input routine to handle both stated point and floating point decimal numbers. The subroutine is entered by an RJ instruction which is immediately followed by a parameter word containing the following information: in the operation section provision will be made for specifying whether the input is on IBM cards or on Unitape, the u address section will contain the number n which is the number of cards to be read, the v address section will contain a "relative address", which may be zero. The following features are of interest.

1) The card input uses a variable field. Only the first 72 columns of the card are used. A card is terminated by a) a blank column anywhere from column 1 to column 72, b) when 72 non-blank columns have been read, c) by the letter C on the card.

2) A number, which in order to be completed would require typing beyond column 72, may be continued in column 1 of the succeeding card if there is a non-blank column 72 on the first card.

3) Loading of the input is terminated in two ways: a) the letter C on the card. b) When n cards, as specified in the u address of the parameter word, have been read.

4) Decimal storage addresses may appear anywhere on any card--each such address must start with the letter S followed immediately by not more than five decimal digits. The number immediately following such a decimal storage address will be stored at the cell whose address is formed by adding to the S storage address the relative address in the v section in the parameter word. Succeeding numbers will be stored in consecutive cells until another S address is encountered.

5) Each number as typed may be followed by a decimal scaling factor in the form D±xx and by a binary scaling factor in the form Bxx. The plus sign need not be specified in the decimal scaling factor; a minus sign is not allowed in the binary scaling factor. This binary scaling is the location of the binary point obtained by counting from the right end starting with digit zero of the word as it appears in the machine.

6) Stated point numbers are specified by a sign followed by not more than eleven decimal digits. Plus signs need not be written. A decimal point may appear anywhere in a stated point number.

7) Floating Point numbers are specified by a sign followed by not more than nine decimal digits followed by the letter F. Plus signs need not be written. No decimal point may be written in a floating point number--the decimal point is to precede the left most digit as written. Originally Lockheed proposed a maximum of eight digits, but after some discussion Lockheed agreed to modify their specifications to allow as many as nine digits in the mantissa part of floating point numbers. It should be stressed that each floating point number must have the letter F immediately following the last digit of the mantissa as described.

8) Complete numbers may be dittoed into consecutive storage locations by successive commas.

9) According to Lockheed the decimal and binary scaling of a number are duplicated on each succeeding word until a different scaling is specified.

The specifications for this generalized numerical data input routine were well received by the Program Development Committee. Lockheed will have more to report on this routine at future USE meetings.

NUMERICAL DATA OUTPUT - Don Cook presented the final specifications on a stated point numerical data output routine which records characters in a fixed block for outputing on the high speed printer. The coding for the routine has been completed and checked out on the 1103A simulator which Boeing has developed for use on another machine. The entire routine requires 316 words including 152 instructions, 23 constants, and 141 temporary registers. The subroutine is entered in the normal fashion with an RJ instruction. There may be as many as 9 parameter words which are to be transferred into the subroutine before entry. The first of these parameter words consists of three parts: the OP code contains the number of columns to be printed per line, the u address section contains the address which is the location of the first of the stated point numbers which is to be printed, the v address contains the number of lines which is to be printed. If the number of columns is specified as zero, a blank line will be printed. The next parameter words are in order: one for each of the numbers to be printed. Each of these parameter words is formed in the following way. The v address contains an integer which is the binary scaling of the stated point number as it stands in storage. The u address contains the decimal scaling, that is, the number of digits which are to be printed preceding the printed decimal point--initial zeros preceding the digits in front of the decimal point are suppressed. The sign of the number immediately follows the lowest order printed digit. Nominally, each printed number occupies eleven character positions followed by a sign; however, if the integer requires eleven digits to be printed, no point is printed. There are three spaces between adjacent columns. The u address part of the scaling parameter words, which specifies the number of digits to the left of the decimal point, must not exceed ten--if it does, the 20's complement of that number will be used. Boeing will circulate copies of the coding of this routine as soon as convenient.

The floating point version of the numerical data output subroutine has not yet been started.

GENERALIZED OUTPUT ROUTINE. Sperry-Rand at St. Paul had originally agreed to produce specifications for a generalized output editing routine--however, due to a shortage of personnel they are unable to continue this project. Therefore, RW and Lockheed Missiles have agreed to try to get some specifications together individually and then approximately three weeks from the date of this meeting discuss the specifications, which may be presented at the next meeting for approval by the USE Organization. George Etsell of Sperry-Rand, now stationed at Boeing in Seattle, handed out copies of a paper written by Donald E. Neilan in September, 1955, entitled "Output Format Generator". The paper starts out with the statement: "The following is a list of suggested specifications for a generated output program. The same specifications should hold for both output to a printer for on-line listing and output to a tape for peripheral listing." This write-up includes some ideas for a very generalized output format generator and undoubtedly will be studied closely by RW and Lockheed before arriving at a set of specifications for the generalized output editing routine.

COMPILERS - Don Cook of Boeing gave a progress report on the Boeing Compiler. Some changes and additions have been made to the original specifications. In particular, the Boeing compiler now accepts octal coding mixed with symbolic. Provision is being made for translation of algebraic coding as an integral part of the compiling routine. The algebraic coding specifications have been formulated, but the coding required to translate algebraic coding has only just started. Viewed in the large the coding of this compiler is about 35% complete. The basic input medium is cards which are then run through a card-to-tape converter--the compiler then works with the tape to make the translation process. The card input will be of the fixed field type. The eight columns at the right of card will be used for identification numbers which will be specified as desired by the programmer but will be ignored by the compiler. Six columns will be alloted to the location symbol, six columns to the operation. Thirty columns will be provided for the two addresses. Each instruction must start on a card and ends with a special symbol at the end of the instruction. The remainder of the card may be used for comments. Certain instructions in the Boeing compiler are of the three-address variety, for example, Floating Add requires three addresses, namely, those of the two operands and the third for the location of the result. The output of the compiler is binary cards--bi-octal tape may also be produced as an option. The Boeing compiler will accept USE language so that USE subroutines may be incorporated into a code without any pre-conversion. There will be no provision for side by side listing, rather the original deck as keypunched may be listed as desired. The compiler will produce a listing tape containing for each line of original coding 1) symbolic location if appropriate 2) octal word, 3) decimal word. The listing tape will also produce a list of errors or pecularities in the use of the compiler language.

Boeing submitted to the USE Organization a letter describing in detail the proposed Boeing modifications to the high speed printer and to the Unityper. The purpose of these changes is to make the Unityper and the high speed printer compatible. The letter was presented to the Policy Committee and considerable discussion took place about how this matter should be handled. The details of these matters are not discussed in the Program Development Committee report but rather may be found in the minutes of the Policy Committee meeting.

RW presented a progress report on the Ramo-Wooldridge Computation System. This consisted of several typewritten pages and Combelic from RW discussed in some detail various salient features of the language which is under development for a compiler at RW. Copies of this progress report were handed out at the meeting--other copies may be obtained from the Chairman of the Publications Committee.

TRANSUSE CONVERSION PROGRAM AND COMMON COMPILER - The latter part of the Program Development Committee Meeting was devoted to a discussion of these subjects. In the past the prospects for a common compiler have been dim because of time pressures imposed on the various organizations by the imminence of the delivery of their 1103A's. However, at the present time, because of delays in the scheduled delivery date of the 1103A computers, certain organizations have found that their time schedules have been considerably eased. In light of this, active cooperation on a common compiler appears to be more likely now than at any time in the past. Considerable discussion took place in the Program Development Committee as well as in the Standards and Policy Committee's meetings, on various aspects of this subject. The discussion seemed to be in two stages. The first stage had to do with the advisability of a so-called minimum Transuse assembly program. Such a program would have as its primary objective the translation of the USE language into some form which may be more suitable for direct use by a compiler. The input to this minimum Transuse assembly program would be programs or subprograms written in the USE language--the form of the output has not been agreed upon. Because of the possibility of cooperation on a Common Compiler, further discussion on the advisability of a minimum Transuse assembly program was deferred. As a result of the discussions on the subject of a commom compiler which occurred during the various meetings an Ad Hoc Committee for a Common Compiler was appointed at the suggestion of Dove from Lockheed. The members of this committee are as follows: Dove (ML), Deckert (BA), Johnson (RR), Tantzen (HO), Combelic (RW), Chairman. It was agreed that this special committee should meet at the RW Corporation from 6:00 to 9:00 P.M. on Friday evening. The proceedings of this Committee meeting and of the results achieved have been incorporated into a separate report entitled "Report of the Ad Hoc Committee for a Common Compiler."

MISCELLANEOUS - The Program Development Committee has asked the Standards Committee to make recommendations on the following matter. Certain USE subroutines have no alarm exit, for example, the stated point arc-tangent routine. In these routines it may be desirable to use this cell as a temporary storage register. The Standards Committee is asked to recommend whether this should be allowed.

The Program Development Committee will meet again in conjunction with a meeting of the entire USE Organization to be held at Holloman Air Force Base in New Mexico on May 21 and 22, 1956.

Donn Combelic, Chairman

April 3, 1956

USE Organization Meeting

March 29 and 30, 1956

Lockheed Missile Systems Division

Report of the Standards Committee

The members of the Standards Committee were:

Bob Tantzen, Holloman AFB
Ed Dodge, Lockheed Missile Systems Division
Ben Handy, " " " "
Al Podvin, " " " "
Bob Rock, " " " "
Sue Knapp, Ramo-Wooldridge
Bob Perkins, "
Earl Joseph, Sperry Rand Univac Division, St. Paul
Tom Dines, " " " " , Seattle
Gus Deckert, Boeing Airplane Company (Chairman)

Topics discussed by the Standards Committee

1. Multiple Entries - It was decided that no USE subprogram would have multiple entries.

2. Coding Format - When each USE member generates the coded format by some automatic means (i.e., high speed printer, unityper, Flexowriter) from a correct symbolic program, they will use their own format. A standard format should contain a standard number of spaces for each location, operation, u-address, v-address. The explanation should be in a form that can be transcribed directly into the machine (i.e., no special symbols, $\sqrt{}$, $\rightarrow$, $\leq$, etc.).

2. Number Conventions - A floating point number can be represented by the following: a sign if negative, mantissa with point; distinguishing character to flag the exponent; sign if negative, exponent. The floating point number will be converted into the standard 1103B floating point system. The exponent for the decimal number will be the true power of ten associated with the mantissa.

4. Timing - The most useful time associated with subprograms is the maximum execution time. This would be calculated using the maximum time for each instruction. There are two types of subprograms, class I - the subprograms with no loops or a maximum number of loops and for this class a known time for each instruction can be

calculated, class II - the subprograms with an undeterminate number of loops and for this class it would be necessary to write a formula in terms of the time for each loop. A method for calculating the maximum number of loops should be included. The minimum and average times for subprograms are very useful, but it was felt that one time was all you could ask someone to calculate for you.

5. Control and Results - All data should be stored in the program starting at t+3, if the data is not stored before entry it will be stored by the program.

6. Standard Card Form - For the USE members who want to transmit programs on cards, a standard card format was set up.

	Card Cols.
Location	1-6
Operation	7-12
U-Address	13-25
V-Address	26-38
Comments	39-72
Seg. No.	73-75
Insert No.	76
Program No.	77-80

7. Standard Scaling - It was proposed that a set of subprograms to evaluate functions with the same scale on input and output be written. Two methods were suggested for accomplishing this.

   a. Using A_L and A_R on input and output.

   b. Scaling the functions down to fit into one word.

   There was no agreement on the need for such a system and it was postponed to a later date.

8. Error Codes - No agreement was reached on the flag to be given when exiting from a subprogram through the error exit. This was deferred until it could be given more thought.

9. Minimum Assembly - There is a need for TRANS-USE which is a two pass assembly program. This program would read symbolic instructions from cards and translate these into an 1103A machine language program stored in the machine at some known location and ready to work from a location supplied by the programmer. The USE language should be enlarged to include constants of all kinds, as well as integers. A committee should be set up to determine the specifications for TRANS-USE.

10. Item F.1. was removed from USE Program Write-Up Form.

REPORT OF THE AD HOC COMMITTEE FOR A COMMON COMPILER

The members of this committee as appointed by the Permanent Chairman of the Policy Committee are as follows:

August Deckert (BA)
Bernie Dove (ML)
Peggy Johnson (RR)
Robert Tantzern (HO)
Donn Combelic (RW), Chairman

Also in attendance at this meeting were Dick Talmadge from ML, and the following from RW, Walter Bauer, Don Gantner, Suzanne Knapp, Robert Perkins, Millard Perstein.

The meeting was held at RW, convening at approximately 6:00 P.M. March 30. The chairman started the meeting by reiterating the directive from the Policy Committee to this Ad Hoc Committee. There were two points involved: 1) To investigate the feasibility of a common compiler for the 1103A, 2) If feasibility is determined, then to decide what steps should be taken in order to achieve the objective of a common compiler.

After considerable discussion about both general points and detail points it was agreed that the specifications for such a common compiler should be listed and tentatively agreed upon. It will be clear when reading the list that these are features which are very unlikely to be disagreed upon by any group of programmers. It is expected that agreement will be somewhat more difficult to reach upon the detailed language and specifications and on the mechanization of these features. The members of the committee agreed that a common compiler should include the following rather general features.

1. Compile subroutines from pseudo-instructions. A pseudo instruction requiring the use of some library subroutine would appear in the main program. The subroutine necessary to carry out the desired function would then be automatically compiled into a so-called compiled region. The line of coding which originally contained the pseudo-instruction would be replaced by the appropriate calling sequence of one or more instructions.

2. Assign cell numbers to otherwise undefined symbolic addresses. Ordinarily these cell numbers will be assigned addresses in a compiled region. This feature allows easy assignment of working storage locations.

3. Use numerical constants as addresses. The compiler should be able to detect that an address section of an instruction is actually a numerical constant. The value of this number would then be stored in an otherwise unused cell in the compiled region--the address of that cell would be filled in as the appropriate address section of the instruction.

4. Symbolic addresses. The compiler should be able to accept symbolic addresses similar to those now accepted as standard for subroutines by the USE Organization. Implicit in the phrase symbolic addresses is the concept of free addressing.

5. Easy method of writing numbers. In this sense a number is a numerical constant which occupies one or more full registers and is ordinarily thought of as a number--this is in contrast to the writing of numerical addresses. It is expected that both stated point and floating point single and double precision decimal numbers will be acceptable to the compiler as well as octal numbers.

6. Ability to generate in-out routines. The thought here is that the programmer could make relatively simple specifications of the form of the numerical output which he desires and that the compiler would generate and assemble automatically the routine necessary to do the particular job specified.

7. Ability to make any type of change easily with both card and tape input. This is obviously a worthwhile and noncontroversial objective. However, the discussion showed that there may be considerable compromise necessary to work out the details of just how such generalized changes would be made.

8. Generate calling sequences. This ability of the compiler was alluded to in point number 1 above. A calling sequence may very well require more than just an RJ--the common compiler should be able to generate automatically these calling sequences in a predictable fashion.

9. Provide binary tape output. In some installations a binary tape output may be the most common form of output, in others, it may be provided as an option. In any case the compiler should have this ability.

10. Provide symbolic side-by-side listing. Some installations have found this type of listing a most useful form of output, particularly during trouble-shooting periods. The symbolic side-by-side listing is to be contrasted with the present method at some installations where the original keypunched cards are listed on one piece of paper; subsequently a related listing showing the translated code (usually in octal) is produced on another piece of paper.

11. Detect errors during input conversion. Clearly typing or syntactical errors may be made in preparing the code and the input cards or tape. A good compiler should be able to detect such errors, make a list of them for use by the programmer, and still continue the conversion if at all possible. This then allows the programmer to study the list of errors and correct as many as possible before returning to the machine.

12. The compiler must be able to handle symbolic programs which are input on either cards or tape--in other words both forms of input must be possible and convenient.

13. Compatibility with mistake diagnostic routines. The form of the input and the provisions made for the programmers use of mistake diagnistic routines must be completely compatible. That is, information which the programmer must specify in order to diagnose coding errors, must be in a form which can be handled by the compiler and is compatible with the ordinary form of input.

14. Can incorporate USE subroutines. The compiler should be able to handle a USE subroutine unchanged from its original symbolic form and incorporate such a subroutine into the main body of a program when that symbolic subroutine is included as part of the original manuscript.

15. Identification of Output. Any material which the compiler produces as output should be completely identified as a matter of routine. For example, the symbolic side-by-side listing should be identified--this would include the programmer's name, the date if possible, program number, etc.

16. Direct input. After the compiler has completed the read-in and compiling of a program, along with any changes which might have been incorporated, the translated program will finally be stored in its operating position so that the program may be executed immediately after compilation has been completed without any intermediate steps being necessary.

17. Compatibility with operational procedures. There should be built into the compiler some provision for handling simple operational instructions having to do with the sequencing and button pushing which are necessary to complete a run on the machine. It is not intended that the inclusion of this point requires that the common compiler shall have built into it automatic operational features--rather the compiler should be planned so that when a particular installation decides that they want to incorporate automatic operational procedures, the compiler will be able to accept these changes without any major modifications.

Another point which was discussed was provision for automatic segmentation of a problem, but it was decided not to include this as a requirement in the common compiler. The sequence in which the above points occur does not indicate in any way their importance or the priority with which they will be considered.

Even after agreeing on the above list, the committee was a long way from answering the question of the feasibility of a common compiler although no one questioned the desirability. Two organizations have done considerable work toward their own versions of a two-pass compiling program, namely, Boeing and RW. The Boeing compiler is approximately 35% complete; the RW compiler is less than 5% complete. The specifications for both of these compilers are fairly firm at the present time. In order not to lose too much calendar time because of changing the specifications, the organizations in question will have to reach a decision on just how much and what specifications they could change in order to produce specifications agreeable to the majority of the member organizations and at the same time not delay the completion of a system for use with their machines when they do arrive. Both Boeing and RW must have a compiling system in operation to handle at least the simple cases by no later than July of this year.

The Chairman at this time sounded out Sperry-Rand and Holloman on their feelings about the matter. Both Sperry-Rand and Holloman indicated that they would most probably go along with any common compiler which incorporated the features which have already been discussed. These two organizations also said that they would be willing to provide a substantial fraction of the manpower necessary to complete the coding and checking out of a common compiler. Boeing's situation is considerably different from that of Sperry-Rand and Holloman. They have gone a long way toward completing their compiler--it has some features, in particular that of accepting algebraic coding, which are not included in the above list. It seemed that it would not be wise to proceed toward setting up the specifications for a common compiler without trying to draw as heavily as possible upon Boeing's experience. Boeing's compiler has been reported upon with respect to specifications fairly completely in the last two or three meetings and write-ups of most of its features are available. Boeing indicated that they would not be in a position to hand out the completed compiler package to any organizations. However, they did say they would be in a position to offer specific parts of it for use by other organizations. As an example of this they have already done considerable work toward producing a numerical data output subroutine for use by the entire organization. In light of this it was clear that the Boeing compiler could not be adopted by USE as the common compiler even if it incorporated all the features which have been listed above.

In light of all these comments it was felt that perhaps the next step should be for RW and Lockheed to try to get together within a week and start consideration of the detailed specifications for a common compiler incorporating the features which have already been listed. Due to the delayed delivery date of Lockheed's 1103A they do now have available a small amount of manpower to devote to this effort.

RW has detailed specifications on a compiler which incorporates most of the desired features which have already been listed. RW took the position that there were some features in their compiler as presently specified which they could not forego.

The matter was left in the following state: Lockheed will undertake a careful study of the specifications of the RW compiler keeping in mind the features which must be incorporated into a common 1103A compiler. Then late next week, before Friday, April 6, Lockheed and RW will start a series of meetings to reach agreement on the detailed specifications of a common 1103A compiler. A set a written specifications will then be presented as soon as possible to the USE members for consideration.

The meeting was adjourned at 8:45 P.M., March 30, 1956.

Respectfully submitted,

Donn Combelic, Chairman
4-10-56

USE Organization Committee Report

Report of the Subcommittee

of the

Ad Hoc Committee for a Common Compiler

The subcommittee has met four times: on April 9, 11, 13, and 25, twice at Lockheed Missiles, twice at Ramo-Wooldridge. Each meeting lasted virtually a full day. The following have attended all the meetings.

Dick Talmadge, ML
Ben Handy, ML
Bernie Dove, ML
Tom Dewey, ML
Donn Combelic, RW
Don Gantner, RW
Robert Perkins, RW

In addition, Millard Perstein, RW, attended part of one of the meetings.

The initial goal of the subcommittee has been to arrive at specifications for a Common Compiler to be submitted for consideration by the entire USE Organization. This goal has been achieved--the results are included herewith as the body of this Subcommittee Report.

I. INTRODUCTION

The purpose of the USE Compiler is to reduce the amount of effort necessary to prepare codes for the 1103A. This compiler will assemble codes written in a symbolic language into 1103A machine langrage; it will perform certain bookkeeping functions normally done by the programmer (storage allocation, calling sequence generation, constant and temporary pool construction, etc.); and, it will provide a simple method for program modification.

Input to the compiler will be from either cards or magnetic tape or a combination of the two. As output, the compiler will produce a magnetic tape which will contain a listing of the absolute octal translation side by side with the symbolic coding.

II. CODING FORMAT

The coding format to be used is divided into four major fields, designated as follows:

A) Item No.; B) A/N Tag; C) Operation; and D) Variable Field.

The last named will include the u and v addresses and comments. Each of the fields must begin with a comma, except that the item number field begins with a special mark.

A. Item No.

The Item No. is a pure decimal number whose primary purpose is for ease in making corrections. The number may have at most six digits to the left of the decimal point, and at most four digits to the right of the point.

The Item No. will be used by the compiler to order the lines of coding, hence simplifying modification references. The number will normally be computed in a sequential fashion by the compiler, but a programmer may insert any number he wishes on any line. The only restriction will be that the number on any given line must be larger than that on any preceding line. The compiler will obey the following rules for generation of item numbers:

1. If more than one digit is found in the Item No. column, the complete number is taken as the item number for that line. The position of the rightmost digit is considered the "index position". If no decimal point is written, the item number is considered an integer.

2. If exactly one digit is found, that digit is extracted into the "index position" of the item number associated with the immediately preceding line of coding.

3. If no digits are found, a one is automatically added into the "index position" of the item number associated with the immediately preceding line of coding.

B. A/N Tag

The A/N Tag is a symbol whose principal purpose is to identify the command associated with the line of coding. The symbol may consist of no more than six alphanumeric characters, at least one of which is alphabetic. Any combination of characters may be used to represent a symbol except the following five combinations:

1) A, 2) Q, 3) D, 4) FILL, 5) all symbols starting with QQ.

The programmer is not required to fill in the A/N Tag field unless he wishes to tag the command for reference.

C. Operation

The Operation is an alphanumeric symbol consisting of no more than six characters. There are three major classes of symbols which may be used in this field:

1. Symbols which refer to 1103A operations and which generate a single machine language command. Under this class are three types of symbols:

   a. Mnemonic 1103A codes -- the two letter codes suggested by Sperry Rand for identification of computer commands.

b. Two octal digits -- any combination of two octal digits will be considered as the operation section of an 1103A instruction. A blank operation field is equivalent to writing 00 in the operation field.

c. 1103A operations involving "j" -- three character codes are provided for the 1103A operations: Left Transmit, Manual Jump, Manual Stop, Punch, Repeat, External Read, and External Write. The three characters will consist of the two letter mnemonic 1103A code with either the proper numeric "j" digit or a third mnemonic character attached. Permissible combinations are as follows:

Left Transmit	(Left Half)	LTL or LT0
" "	(Right Half)	LTR or LT1
Punch	(6 hole code)	PU6 or PU0
"	(7 hole code)	PU7 or PU1
Repeat	(Modify v only)	RPV or RP1
"	(Modify u only)	RPU or RP2
"	(Modify u and v)	RPB or RP3
External Read	(through IOA)	ERA or ER0
" "	(through IOB)	ERB or ER1
External Write	(through IOA)	EWA or EW0
" "	(through IOB)	EWB or EW1

2. Symbols which refer to instructions to the compiler and which may generate several machine language commands (such as a subroutine calling sequence) or may generate no machine language commands. Under this class are two types of symbols:

   a. Control Symbols -- these are pseudo-commands which enable a programmer to interrupt and modify some of the automatic functions of the compiler.

   b. Subroutine Designation Symbols -- these are pseudo-commands which will call for the inclusion of subroutines in the compiled program and will set up the generation of the calling sequence.

3. Certain alphabetic characters (B, F, G, X, or Y) are used to specify that the content of the variable field is not an instruction but a number which will occupy one or two memory locations. The letters have the following meaning with respect to the number found in the Variable Field:

   B - an octal integer
   F - a single precision floating point decimal number
   G - a double precision floating point decimal number
   X - a single precision stated point decimal number
   Y - a double precision stated point decimal number

D. Variable Field

The content and format of the Variable Field is determined by whether the symbol in the operation field designates a machine type instruction or a number. If it is a machine type instruction, a comma must be used to specify the beginning of the u and the v addresses. If comments are used a comma is necessary to flag the beginning of the comments. Regardless of the content, the total number of characters in this field, including all special marks, must not exceed 60.

1. Machine Type Instruction -- an instruction requiring a u and/or v address which may contain any of the following in the u and/or v address:

   a. Decimal Address.

      A decimal integer.

   b. Octal Address.

      An octal integer followed by the notation)B.

   c. The symbols A, Q, D and FILL.

      The symbols will be translated as 32000)B, 31000)B, 40000)B, and 30000)B, respectively.

   d. Constants.

      Defined by the special designation L(c), where c is the actual constant written in the form of a number.

   e. A/N Tag.

      Any symbol appearing in the A/N Tag column.

   f. Item Number.

      Any item number with the special distinction that it must contain a decimal point.

   g. Storage Address.

      A symbolic address or item number followed by the notation)S.

   h. Undefined Symbols.

      Symbols which could appear in the A/N Tag column but which do not.

   i. Multiple Addresses.

      Sums and differences of items a through h.

2. Numbers.

   The u and v addresses are considered as a unit when writing numbers. The writing of numbers is completely arbitrary as regards the position of the decimal point and the length of the number providing the written number is consistent with the machine limitations. Scaling of numbers is accomplished by writing a decimal and/or binary factor after the number. The decimal scale factor being preceded by a D and the binary factor by a B. Any plus sign may be omitted. The type of numbers which can be compiled are:

a. Octal Integers.

Any octal integer with no more than 12 digits.

b. Floating Decimal Numbers.

Any decimal number which can be expressed in floating point form as a single or double precision number.

c. Stated Point Numbers.

Any decimal number which can be expressed as a single or double precision number.

Comments can be written as desired after the address portions of a command but the comments must be preceded by a comma.

III. ASSIGNMENT OF LOCATIONS

Each word in the assembled program will be associated with two machine locations:

A. A storage location at which the word is to be stored at the start of the program, and

B. An execution location which the word is expected to occupy when it is used in the program.

These two machine locations may be the same (and usually will be unless the problem requires segmentation).

The compiler will contain two location counters, one for storage addresses, the other for execution addresses. These will normally be set to 3 at the beginning of compilation. As computer words are generated, these counters will be incremented by one. However, the programmer will be able to interrupt the sequential assignment of either or both of these addresses, and will be able to insert a new starting point at any time he desires.

When the compiler begins its translation program it examines the A/N Tag, the u and the v addresses.

If a symbol appears in the A/N Tag field before it appears in u or v, it is entered into a table of location symbols as the argument and the setting of the storage and execution counters are entered in the table as the function values. If a symbol appears more than once in the A/N Tag field it will be considered an error by the compiler.

If a symbol appears in the u or v addresses before it appears in the A/N Tag, it is entered into the table of location symbols as the argument and the function value entry is left blank. If further along in the program, the symbol is encountered in the A/N Tag, the setting of the storage and execution location counters at this time is entered into the table as the function value. If the symbol is not defined anywhere in the A/N Tag field, the compiler will automatically assign a storage and execution location, and will enter this assignment into the table.

If an item number appears in the u or v addresses, this number is entered into a table of item number locations as the argument, and the setting of the storage and execution location counters for that number will be entered as the function value.

If the notation L(c) appears in the u or v address, the compiler will scan a table containing constant pool assignments. If the number c appears in the table no further assignment will be made; if the number c is not entered in the table, the compiler will make an automatic assignment of storage and execution locations and enter this in the constant pool table.

Whenever a subroutine is referenced in the Operation field, the compiler will examine the v address of the command. If this address contains a symbol, location assignments will be made according to the rules for symbols in u and v addresses. If the v address is blank, the compiler will store the symbol from the Operation field in the symbolic location table and will assign storage and execution locations in the manner reserved for undefined symbols.

In order to make the automatic assignments referenced above, the compiler will generate a region, called the compiled region. In this region will be assigned locations for subroutines, the subroutine temporary pool, the constant pool, and for those symbols not appearing in the A/N Tag field. This region will normally be located in the high end of memory and a compiled region location counter will be used to keep track of all assignments. This counter will be set at 4095 at the beginning of compilation and will normally be decremented by one for each machine location assignment. However, the programmer will have the ability to locate this region anywhere in memory.

IV. PSEUDO OPERATIONS

A. Control Commands

These are instructions to the compiler and do not normally occupy cells in the machine.

1. SETLOC (Set location counters)

   The pseudo operation SETLOC sets the execution location counter and storage location counter to the translated values of the u and v fields respectively. If either of the fields are left blank then the corresponding counter is left undisturbed. The u and v fields may have address structures as described under Variable Field except that any symbols used must have been previously defined.

2. EQUALS

   The effect of the pseudo operation EQUALS is that the symbol in the tag column is given the execution address specified by the u field and the storage address specified by the v field. If the v field is blank, the storage address becomes the same as the execution address. The u and v fields may have address structure as described under Variable Field except that any symbols used must have been previously defined.

3. COMPAT (Compile at)

The pseudo operation COMPAT instructs the compiler to begin the compiled region at that location specified by the translated value of the u field. If the v field is blank the storage address becomes the same as the execution address. One of two alternatives will occur if a symbol appears in the tag column:

a. If the u and v fields are both not blank, the symbol appearing in the tag column will be treated as if the pseudo operation were EQUALS and the compiled region will begin at that location specified in u.

b. If the u and v fields are both blank, the compiler will assign the start of the compiled region and the symbol appearing in the tag column will be equated to that assigned location.

The contents of the u and v fields may be the same as described under SETLOC. The control command COMPAT may be used only once in the compiled program.

4. RESERV (Reserve)

The RESERV operation reserves, in memory, a block of cells. Any symbol appearing in the tag column will be assigned the current values of the location counters. The location counters will then be incremented by the amounts specified in the u and v fields respectively. If either of the fields are left blank, the corresponding counter will be left undisturbed. The contents of the u and v fields may be the same as described under SETLOC.

5. DUPj

The pseudo operation DUPj instructs the compiler to repeat all, or part, of the command on the line of coding which follows. The "j" part of the operation specifies what part of the command is to be repeated:

a. O designates repeating the operation field.

b. U designates repeating the u field.

c. V designates repeating the v field.

"j" may consist of any combination of the letters O, u, v provided the sequence O, u, v is preserved. The number of times the line is repeated can be specified in either of the following two ways:

a. DUPj, n, TIMES

Where n is an integer in the u field specifying the number of times the repeat is to be executed and includes that line which is repeated; and TIMES is in the v field.

b. DUPj, THRU, ALPHA

Where THRU is in the u field; and ALPHA is the A/N Tag (or Item No.) associated with the last line of coding on which the repeat is to operate.

Any legitimate entry may be made in those fields which are not repeated.

6. END

The pseudo operation END is on the last line of coding; there must not be a symbol in the tag column; the u field is ignored; the v field may be as described under SETLOC. This signals the end of the program to be compiled. It also sets up a transfer of control to the address designated in the v field, to be executed after the compiled program is loaded.

B. Subroutines

Subroutines are called by a pseudo-command to the compiler constructed as follows:

1. The operation field contains a tag identifying the subroutines, such as SIN1, SQR2, etc.

2. The u field is the symbolic location (A/N Tag) of the argument. If the subroutine has more than one argument, say n, this location is that of the first argument. The programmer is then required to see that the remaining arguments are available in the n-1 cells following the one tagged.

SEE supplement

3. The v field is the symbolic location of the first cell of the body of the subroutine. If this field is blank, the subroutine is placed in the compiled region, and the symbolic location of the first cell is the subroutine identification tag.

The compiler supplies the proper calling sequence for the subroutines. This calling sequence is located in the program at the point where the pseudo-command was found by the compiler. If the pseudo-command itself has an A/N tag, this tag will refer to the first word of the calling sequence.

Some examples are as follows:

	Tag	OP	u	v
1.	α	SIN1	X	
2.	α	SIN1	X	YZ
3.	α	SQR2	SO2	α

In example 1, the SIN1 subroutine is placed in the compiled region, the argument is taken from location X, and the calling sequence starts at location α.

In example 2, the SIN1 subroutine is placed at location YZ. It is the programmer's responsibility to see that the proper number of cells are available at this location. The rest is the same as example 1.

In example 3, the programmer has made an error, since the location of the SQR2 routine at α will destroy the calling sequence at α . He will need to insert a manual jump at the previous cell and repair the damage himself.

In addition to the regular library routines, the compiler will accept subroutines, in a properly prepared form -- namely, the standard USE subroutine format -- from cards, or from manuscript. In the latter two cases the subroutine pseudo-command is preceded by a <u>control word</u> to the compiler. This control word has the following construction.

1. The operation field has either SUBRC or SUBRM. The first indicating that the subroutine is on cards, ready to be read in; the second indicating that the subroutine is in manuscript form; and, in fact, follows the subroutine pseudo-command.

2. The u field indicates the number of cards, or lines of coding, in the subroutine.

3. The v field is not used at present.

Some examples:

	Tag	OP	u	v
1.		SUBRC	5	
		SIN2	X	
2.	H2S	SUBRM	42	
		SQR2	ARG	A2D

Example 1: The SIN2 subroutine, which is to be put in the compiled region, and whose argument is at X, is located on 5 cards, one word per card, now available in the card reader.

Example 2: The subroutine SQR2 which is to be located at A2D, argument at ARG, calling sequence at H2S, is located in the 42 lines of coding following the pseudo-command.

Since the cards for a subroutine may not be conveniently available for recompilation, compiling from cards is done only once; at which time the SUBRC control word is replaced by SUBRM, the words on the cards are inserted in the manuscript following the subroutine pseudo-command, and the listing is adjusted accordingly. In addition, since each line of coding must have an item number, item numbers are automatically generated by the following rule: if j is the item number of the subroutine pseudo-command, the subroutine words have the item numbers j+.001, j+.002, ..., j+n(.001), regardless of the index position of the item number j.

As a simple example, if the two word subroutine (?), named NULL

TP, A, Q

LQ, Q, 35

is on cards, the original coding might read:

ITEM NO.	A/N TAG	OP	u	v
15.		SUBRC	2	
16.	R,	NULL,		
17.		TP,	Q,	A

After the first stage of the compilation has been completed, this will be replaced by the coding:

15.		SUBRM	2	
16.	R,	NULL,		
16.001		TP,	A,	Q
16.002		LQ,	Q,	35
17.		TP,	Q,	A

As a final remark it should be noted that an A/N tag for the control command is meaningless, since it produces no machine command to be referenced.

V. CHANGES

Changes are specified by means of the item number and placed on a change tape. The key rule to remember is that the item number is irrevocably tied to a line of coding and is never changed. A partial exception to this rule is allowed in the case of replacement, which results in a considerable economy without incurring ambiguity. For a particular problem, if a line is deleted, its item number disappears from circulation; if a line is added, its item number is distinct from all others in current use.

Types of changes allowed are:

A. Deletions

If the original program is in manuscript form, deletions can be accomplished by merely crossing out the line of coding. For the change tape, deletions are specified in one of two ways:

	ITEM	TAG	OP	u	v
1.	12.52,		Delete	13,	lines
2.	175,		Delete,	Thru,	181.2

In each case, the item number of the control word is that of the first word to be deleted.

B. Replacements

Replacements are accomplished by writing the new line of coding for the change tape exactly as it would have been written for the original program, except that the item number must be written in full.

C. Insertions

Insertions are made by assigning distinct item numbers for each instruction to be inserted.

In general, the following simple rules should prove effective in guiding the programmer for both insertions and replacements:

1. The item numbers, when finally assembled, are in sequence.

2. No duplications are allowed.

For example, rule one shows that in the sequence 15, 16, 17, the insertion 15.5, 15.6, followed by the insertions 15.55, 15.58 would result in the final sequence 15, 15.5, 15.55, 15.58, 15.6, 16, 17. Note that rule 2 is essentially that for replacement: since two distinct lines may not have the same item number, the old line must be replaced by the new. An error results, when item numbers are duplicated among the changes.

Respectfully submitted

Donn Combelic

Donn Combelic, Chairman
April 25, 1956

B. Subroutines

There are two pseudo-commands for calling subroutines.

1. The first pseudo-command is constructed as follows:

   a. The operation field contains the tag identifying the subroutine, such as SIN1, SQR2, USE023, etc.

   b. The u address contains the symbolic location of the argument. If the subroutine has more than one argument, say n, this location is that of the first argument. The programmer is then required to see that the remaining arguments are available in the n-1 cells following the one specified.

   c. The v address contains the symbolic location of the first cell of the body of the subroutine. If this address is blank the subroutine is placed in the compiled region. If a symbol, say @, appears in the address, then the subroutine is written for storage at @)S and execution at @.

   This type of pseudo-command generates a calling sequence for the subroutine. This calling sequence is located at the point in the program where the pseudo-command was found by the compiler. If the pseudo-command itself has an A/N tag, this tag will refer to the first word of the calling sequence.

   This type of pseudo-command does not reserve any cells for the subroutine.

2. The second pseudo-command is constructed as follows:

   a. The operation field contains the word LOCATE.

   b. The u address contains the tag identifying the subroutine.

   c. The v address is left blank.

   This type of pseudo-command does not generate a calling sequence for the subroutine. However, it does allocate the proper amount of storage; functioning, in this respect, like an automatic RESERV.

In addition to the regular library routines, the compiler will accept routines, written in the standard USE subroutine format, from cards, or from manuscript. In these cases the subroutine pseudo-command is supplemented by a control word to the compiler, which has the following construction:

1. The operation field has either SUBRC or SUBRM. The first indicates that the subroutine is on cards, ready to be read in; the second that the subroutine is in manuscript form, and, in fact, follows the control word.

2. The u address contains the tag identifying the subroutine.

3. The v address is left blank.

Since the cards for a subroutine may not be conveniently available for recompilation, compiling from cards is done only once; at which time the SUBRC control word is replaced by SUBRM, the words on the cards are inserted in the manuscript following the control word, and the listing is adjusted accordingly. In addition, since each line of coding must have an item number, item numbers are automatically generated. (The applicable rule is II.A.3).

This control word may appear anywhere in the coding before the control word END. However, if used in conjunction with the LOCATE type pseudo-command, the storage allocation feature of this pseudo-command makes it imperative that the control word precede the pseudo-command.

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Final

~~TENTATIVE~~ AGENDA

USE CONFERENCE

HOLLOMAN AIR FORCE BASE

21 - 22 MAY 1956

Monday, 21 May

9:00 a.m. Policy Committee Meeting

I. Introductions

II. Completion of Agenda

III. Old Business:

A. Approval of minutes of previous meeting.

B. Consideration of written reports of committee chairmen.

C. Oral progress reports from chairman of special compiler committee. standards report Deferred Till Tues.

D. Progress report on modifications to high speed printer.

IV. New Business:

A. Discussion of delegating customer-manufacturer relations committee to consider:

Jules to write letter on prog man. 1. A comprehensive programming manual for the 1103A.

No act at present 2. The addition of a real time clock to the computer.

3. Future 1103A developments

B. Consideration of the USE organization proposal by Lockheed. (See enclosure: Proposed Organizational Structure of USE, by B. F. Handy, B. C. Dove, T. H. Dewey)

12:00 noon Lunch

1:30 p.m. Working Committee Meetings

I. Program Development Committee

A. Progress report, coding assignments.

B. Report on Tape Handlers - ML.

C. Progress on generalized print-edit routines - ML and RW.

D. Revision of coding assignments in light of compiler development.

E. Input - Output & debugging

II. Standards Committee

A. Possible revision of standards ~~for~~ in light of the common compiler.
B. standarization of typing format

III. Compiler Committee (to meet concurrently with Program Development Committee)

A. Some details of mechanization.

B. Coding assignments.

Tuesday, 22 May

9:00 a.m. Continuation of Committee Meetings

11:00 a.m. Individual Membership Caucus.

12:00 noon Lunch

1:30 p.m. Policy Committee Meeting

I. Unfinished business of previous session.

II. Oral reports of committee chairmen.

III. Items for agenda of next meeting.

IV. Date and place of next meeting. 4 YES 1 ABSTAIN; 12-13 July St. Paul.

Time (Undetermined) Tour of Holloman Air Force Base

PROPOSED ORGANIZATIONAL STRUCTURE OF USE

By B.F. Handy, P.C. Dove, and T.H. Dewey

A critical examination of the accomplishments of USE since its inception in December, 1955, will demonstrate, to even the most skeptical person, the value of such an organization. It has already provided a means of exchanging information and ideas on programming and coding, and has established itself as an effective device for increasing cooperation and communication between Sperry Rand and ERA 1103A users.

But this same examination would indicate that several serious flaws remain in the organizational structure. Some of these are: (1) what was originally intended to be a meeting of the Policy Committee has instead become a general meeting in which all take part (this has had the effect of increasing debate and retarding decisions); (2) the decision to permit non-member participation in USE meetings has uncovered the fact that no procedure exists for limiting the participation of visitors in committee deliberations; and (3) no formal statement of the organizational structure of USE is in existence, except through reference to the minutes of the various meetings.

The following proposal is an attempt both to remove these flaws and to prevent any new ones cropping up in the near future. In order to cover all the points, this proposal is submitted in a form normally used for constitutions, but is not intended to be such, except incidentally. It is merely a formal statement of the proposed organizational structure of USE, and of the rules by which it is governed.

Since USE is a voluntary organization, nothing in this proposal is to be construed as requiring absolute adherence to USE decisions by any installation. However, participation in USE activities, and acceptance of USE benefits will be considered as tacit willingness to abide by USE decisions wherever practicable.

~~A Statement of the~~

~~the Organization~~

NAME AND PURPOSE

This organization shall be known as USE (Univac Scientific Exchange), and the primary purpose of this organization shall be the promulgation and exchange of ideas and information concerning programming and coding for the 1103A, and the establishment of a forum where in [redacted] 1103A users and Rep. of the ~~Sperry Rand Corp.~~ Rem Rand Univac Division can discuss suggestions for machine development ~~modification and~~ and additional equipment to their mutual benefit.

MEMBERSHIP

Membership in this organization is ~~strictly~~ voluntary. ~~and~~ members will be classified in two groups: voting and non-voting.

1. Voting-member installations shall be defined as those organizations which meet at least one of the following qualifications:

(1) Now own or rent an [redacted] 1103A

or (2) Have a firm order for an [redacted] 1103A.

2. Non-voting-member installations shall be defined as those organizations which are desirous of participating in the functions of USE but who are not eligible for voting membership under (1) or (2) above.

1. An organization becomes ~~eligible for~~ a voting member~~ship~~ upon presentation to the Executive Secy USE of application for membership and evidence of meeting one of the following two requirements: (1), & (2). ~~of proper qualification to the USE membership. No qualified organization desiring voting-member status shall be rejected by any vote in the USE organization.~~

2. An ~~installation~~ organization desiring non-voting-member status must submit a request to the Executive Secretary of USE. Upon receipt of such a request, the Executive Secretar will submit the installation's name to the membership for vote, either by mail or in a regularly scheduled meeting. Vo~~ting will be by voting-member installations only.~~ A majority of the total membership shall be sufficient to admit an installation to non-voting-member status.

Visitors ~~not directly connected with USE,~~ may be invited by the chairman to attend ~~the~~ meetings as non-participating observers or as special consultants to a committee.

OFFICERS

The officers of USE shall consist of a chairman and an executive secretary.

CHAIRMAN - Term of Office and Qualifications

The Chairman shall be elected for a term of one ~~calendar~~ year, ~~from~~ beginning 1st April ~~the anniversary date~~ and must be a representative of a voting-member installation. Any chairman may succeed himself ~~for as long as the membership desires him~~. The chairman shall have the power to appoint a chairman pro tem at any time.

Duties

The Chairman will officiate at all USE meetings. He will also serve as the Chairman of the Policy Committee during his term of office, and will be an ex officio member of all other committees, both standing and otherwise.

The Chairman will be responsible for the preparation of a tentative agenda for each meeting of USE and will submit it to the Executive Secretary for reproduction and distribution to the member installations before the meeting.

EXECUTIVE SECRETARY - Term of Office and Qualifications

The Executive Secretary shall be elected for a term of one ~~calendar~~ year, beginning 1st April, ~~from the anniversary date~~ and must be a representative of a voting-member installation. Any exec sec'y may succeed himself.

Duties

The Executive Secretary will reproduce and distribute all items of official USE records, which will include the minutes of all meetings, all committee reports, and the tentative agenda drawn up by the Chairman. He will also be responsible for processing applications for membership, either for voting or non-voting status. He will issue invitations to persons or installations not directly concerned with USE, permitting attendance at USE meetings, as directed by the Chairman of USE.

Duties (cont.)

The Executive Secretary will maintain files of all USE records and of all official USE correspondence.

The Executive Secretary will also serve as the Chairman of the Publications Committee, and in such position will ~~be responsible for editing all programs and codes submitted for publication by USE. He will~~ have the power to refuse to publish or distribute anything through USE channels or under the USE name which does not meet the standards set up up USE.

MEETINGS

Meetings of USE will be held at the discretion of the membership. Each member installation in turn will act as the host for a meeting and will be responsible (1) for providing suitable accommodations, (2) for making housing arrangements or providing information concerning available housing, and (3) for providing a recording secretary, who shall be a stenographer.

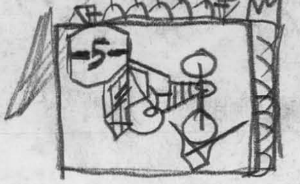
Each member installation is requested to have at least three representatives at each meeting. ~~Visitors participation in any meeting will normally be in the role of observer or consultant, and will require an invitation from the Chairman of USE.~~

GOVERNMENT OF USE

The governing body of the USE organization shall be called the Policy Committee.

POLICY COMMITTEE

This committee shall consist of the Chairman of USE as the chairman and of one representative only from each voting-member installation.



Duties

It shall be the responsibility of the Policy Committee to guide the activities of USE into productive channels. If any action of USE does not meet with the approval of the Policy Committee, it may veto such action without recourse to the general meeting of USE.

All meetings of the Policy Committee will be closed meetings except where by a majority vote of the members of the committee they shall be open to the public.

The Chairman will be a non-voting-member of the committee.

The Policy Committee will study all ideas submitted in the general USE meeting, especially all suggested changes for existing hardware, and will propose items for consideration either by the general meeting or by any of the standing committees.

All final decisions concerning the USE policy will rest in this committee, and may be changed only by a vote within this committee.

The Policy Committee will meet at the discretion of the Chairman, except that it will convene at each general USE meeting. Any member of the Policy Committee may request a meeting of the committee, whenever he feels that any vote in the general USE meeting should be considered by the Policy Committee.

STANDING COMMITTEES

There ~~will be~~ are at present three standing committees: (1) Program Development; (2) Standards; and (3) Publications.

Ins at 7A

The size and membership of the standing committees shall be at the discretion of the policy committee.

~~These committees will each consist of a chairman who must be a representative of a voting-member installation and at least one representative from each member installation.~~

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Each chairman of a standing committee will make an oral report to the general USE meeting which will outline the subjects discussed and will contain the recommendations of the committee. These reports will be considered accepted if the members of the various committees are satisfied that they are complete and accurate. ~~Acceptance of the report will not imply acceptance of the recommendations.~~

Acceptance and implementation of any recommendations will require Policy Committee approval. ~~At the time the oral report of a standing committee is made any member of the Policy Committee may request that the recommendations contained in this report be considered by the Policy Committee. If no action is initiated by any member of the Policy Committee, the recommendation will be considered accepted.~~

The Chairman of each committee will submit a written report to the Executive Secretary for distribution to the members of USE. If, upon receipt of the written report of the Chairman, any member of the committee feels that it is incomplete or erroneous in some part, he will communicate directly with the Chairman of the committee, who will submit an amended report to the membership at the next meeting.

These committees will normally meet during the period set aside for the general USE meeting, but the Chairman of the committee may call a meeting at any time. However, at least one week's notice must be given to each committee member whenever a meeting is to be held not during a general USE meeting. The meetings of these committees will be open, ~~to any representative of a member installation.~~ and Invited guests may ~~not~~ take part in committee deliberations ~~except~~ by direction of the Chairman.

End of page 5 Ins 5A

The Policy Committee will have the power to dissolve or replace any existing standing committee or add new ones.

~~The chairmen of all standing committees except the Publications Committee will be appointed by the Chairman of USE with the consent of the Policy Committee, and will serve for one year (concurrent with the term of the Chairman of USE) unless relieved by vote of the Policy Committee.~~

~~The Chairman of the Publications Committee will be the Executive Secretary of USE, and will serve for the term of the Executive Secretary.~~

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PROGRAM DEVELOPMENT Committee

The function of this committee ~~will be~~ is to study methods of interchange of ideas and techniques. It ~~will~~ shall attempt to achieve voluntary cooperation on programs, codes, assignment of work, and to avoid duplication of effort wherever possible.

STANDARDS Committee

The function of this committee ~~will be~~ is to establish the standards necessary to facilitate the transmittal of programming efforts through USE channels.

PUBLICATIONS Committee

The function of this committee is to set up and maintain proper standards of communication between member installations; to edit all material submitted for distribution under the USE name. In addition, the Publications Committee member from each installation will be responsible for seeing that any material submitted to USE from his installation meets all of USE standards.

~~OTHER COMMITTEES~~

~~All other committees will be appointed by the Chairman of USE, with the approval of the Policy Committee, and will serve at his discretion.~~

VOTING PROCEDURE

~~GENERAL USE MEETING~~

~~In the general USE meeting, voting will be by participants except that visitors will not be counted. A majority of persons present, excluding visitors, will be necessary to carry any vote. The agreement of the Policy Committee is necessary to make any vote official.~~

~~Any member of the Policy Committee may request that a proposal under discussion be submitted to the Policy Committee for consideration. If no such request is received by the Chairman, he may declare the vote official. If the request is received, the vote of the Policy Committee will be final.~~

POLICY COMMITTEE MEETING

A quorum of the Policy committee shall consist of ~~In the Policy Committee, voting will be by voting-member installations.~~ of at least 60% of the voting membership. At least ≥ 2/3 "yes" and no more than a 1/4 "no" of those present shall be required to pass a motion in the Policy Committee, except that a motion to invite non-member participation shall only require a majority vote. ~~of voting-member installations.~~

STANDING COMMITTEE MEETINGS

~~In the standing committees, voting will be by member installations.~~ A majority of members ~~installations~~ present will be necessary to pass any motion in a ~~the~~ standing committee~~s~~.

MINUTES OF THE MEETING OF USE

AT

HOLLOMAN AIR FORCE BASE

NEW MEXICO

21-22 May 1956

The Meeting opened on Monday 21 May 1956 at 9:00 a.m. with a welcoming address by Col. Judy of HADC.

In attendance were:

Lockheed Missile Division

Richard B. Talmadge, Chairman
Bernard C. Dove, Policy Committee Member
Tom H. Dewey

Boeing

Donald J. Cook, Policy Committee Member
William K. McKinley

Remington Rand

Jules Mersel, Policy Committee Member
Earl Joseph
Irvin V. Voltin
Tom Wilder (San Francisco)
Tom Dines (Seattle)
Jack Rose (Los Angeles)
Robert H. Wallace (San Antonio)
Peg Johnson

Ramo Wooldridge

Donald W. Gantner, Policy Committee Member
Donn Combelic
Robert Perkins

WADC

Carl S. Fluke
Leonard B. Fall

Applied Physics Lab (Johns Hopkins)

Robert P. Rich

Corps of Engineers, Washington

John W. H. Spencer

Shell Development

Donald Holmes

HADC

Marvin C. Green, Policy Committee Member
James A Ward
Garner McCrossen
Robert G. Tantzen
Owen Hoke
Herbert Lotze

Following the introductions, the tentative agenda was discussed and the following changes made:

IV. New Business

A. 3. Future 1103A Developments (addition)

Program Development Committee Agenda

E. Input-Output and Debugging Routines (addition)

Standards Committee Agenda

A. Possible revision of standards in light of common compiler (revision)

B. Standardization of Typing Format (addition)

The revised agenda was accepted as well as the minutes of the previous meeting.

Since no one had received a copy of the Standards Committee report, it was agreed to have this report reproduced and distributed during the meeting. Consideration and acceptance was deferred until Tuesday afternoon.

Following a discussion of Boeing's obligation to write a floating point output routine, during which it appeared that Remington Rand had already written such a program, the report of the Program Development Committee was accepted.

Don Cook led a discussion on the proposed modifications to the high speed printer. The following points were established:

1. The modified printer will be available about one month later than the standard printer at an additional rental of about $600.00 per month.

2. The modified printer will be listed by Remington Rand and should be ordered through the regular sales representative. Price lists will be forwarded as soon as possible.

Next, the report of the Special Committee for the Common Compiler was distributed. This report, along with a two page supplement regarding subroutines, outlined the agreement reached by Lockheed and Ramo Wooldridge on the specifications. In addition, agreement on a modus operandi for implementing the specifications was outlined. In effect, the Ramo Wooldridge people are to make the decisions, with Lockheed supplying a man to be at Ramo two or three times a week to help with flow charting and coding, and to serve as liason between Ramo and coding personnel at Lockheed.

During the discussion, Boeing volunteered their compiler to USE. It was moved by Jules Mersel of Remington Rand and seconded by Bernard Dove of Lockheed that the specifications as outlined by the report be accepted as the USE compiler. Marvin Green of HADC requested that the vote be tabled in order to consider the Boeing compiler. After some discussion, during which it was brought out that the Boeing compiler is designed for card-to-tape operation, Green withdrew his request. The motion by Mersel was then carried unanimously.

Mersel then moved that the work of building the compiler fall under the supervision of the Program Development Committee. The motion was seconded by Don Cook of Boeing, and carried unanimously.

It was pointed out that the function of the Publications Committee members at each installation is to edit material for proper format for transmittal as specified by the Standards Committee, Hence, the Standards Committee was asked to consider the formal transmission of routines from one organization to another within the language of the compiler itself.

Visitors present were polled as to the possibility of their joining USE as members. The Applied Physics Lab representative said that they probably would want to join later after receiving approval of their superiors. The Corps of Engineers and WADC indicated similar feelings.

The Policy Committee decided to serve in its entirety as the customer-manufacturer relations committee to consider items IV. A. of the agenda.

The meeting was adjourned until the following afternoon in favor of the various committee meetings.

Afternoon Session - 22 May 1956

Oral report of Policy Committee (R. B. Talmadge).

Jules Mersel was appointed a subcommittee of one to express the need of a comprehensive programming manual for the 1103A.

There was not enough immediate interest in the addition of a real time clock to the computer to warrant any action by the committee.

Discussion of future 1103A developments indicated that the member organizations would like to be in on the planning stage discussions with the manufacturer. No action was taken, inasmuch as it was uncertain as to what, if anything, could be done.

The Lockheed proposal for the organizational structure of USE was revised and adopted. It appears as a supplement to these minutes entitled "A statement of the basic policies of the Univac Scientific Exchange".

Oral report of the Program Development Committee (D. Combelic).

Floating point numbrical data output -- to be completed by Remington Rand.

Generalized output editing routine -- development of that program is not assigned at present. However, John Spencer of Army Corps of Engineers has had experience with a routine similar to the one desired and agreed to obtain a copy of the specifications, and such other information as seemed pertinent, for distribution to the members.

Diagnostic routines -- Lockheed has coded a logic trace and a memory dump which will be machine checked in July and distributed. Ramo Wooldridge will try to write up their diagnostic routines for general distribution.

Tape handlers -- Lockheed is working on a tape duplication and comparison routine. This should be finished and machine checked in July.

Card input -- Lockheed has coded the generalized numerical data card input routine. It also should be checked in July.

Oral report of Standards Committee (K. McKinley).

It was decided that all programs transmitted by USE should be in the language of the common compiler. Any symbol used should be common to Unityper and card and tape converter.

For subroutines, the average time will be given as well as the maximum time. An explanation of how average time was computed must accompany the write-up.

Time and Place - Next Meeting

After some discussion involving time schedules, Don Gantner of Ramo Wooldridge moved that the next meeting be held in St. Paul on 12 and 13 July with Remington Rand as the host organization. The motion was seconded by M. Green and carried by a vote of 4 yes, 1 abstain.

The meeting was adjourned at 3:00 p.m. 22 May 1956.

A STATEMENT OF THE

BASIC POLICIES OF THE

UNIVAC SCIENTIFIC EXCHANGE

ADOPTED 22 MAY 1956

NAME AND PURPOSE

This organization shall be known as USE (Univac Scientific Exchange), and the primary purpose of this organization shall be the promulgation and exchange of ideas and information concerning programming and coding for the 1103A, and the establishment of a forum wherein 1103A users and representatives of the Remington Rand Univac Division can discuss suggestions for machine development and additional equipment to their mutual benefit.

MEMBERSHIP

Membership in this organization is voluntary. Members will be classified in two groups: voting and non-voting.

1. An organization becomes a voting member upon presentation to the Executive Secretary of USE of application for membership and evidence of meeting one of the following two requirements:

(1) Now owns or rents an 1103A

or (2) Has a firm order for an 1103A.

2. An organization desiring non-voting member status must submit a request to the Executive Secretary of USE. Upon receipt of such a ~~report,~~ REQUEST the Executive Secretary will submit the installation's name to the membership for vote, either by mail or in a regularly scheduled meeting. A majority of the total membership shall be sufficient to admit an installation to non-voting member status.

Visitors may be invited by the Chairman to attend meetings as non-participating observers or as special consultants to a committee.

OFFICERS

The officers of USE shall consist of a chairman and an executive secretary.

CHAIRMAN - Term of Office and Qualifications

The Chairman shall be elected for a term of one year, beginning 1st April, and must be a representative of a voting member installation. Any chairman may succeed himself. The Chairman shall have the power to appoint a chairman pro tem at any time.

Duties

The Chairman will officiate at all USE meetings. He will also serve as the Chairman of the Policy Committee during his term of office, and will be an ex officio member of all other committees, both standing and otherwise.

The Chairman will be responsible for the preparation of a tentative agenda for each meeting of USE and will submit it to the Executive Secretary for reproduction and distribution to the installations before the meeting.

EXECUTIVE SECRETARY - Term of Office and Qualifications

The Executive Secretary shall be elected for a term of one year, beginning 1st April, and must be a representative of a voting member installation. Any executive secretary may succeed himself.

Duties

The Executive Secretary will reproduce and distribute all items of official USE records, which will include the minutes of all meetings, all committee reports, and the tentative agenda drawn up by the Chairman. He will also be responsible for processing applications for membership, either for voting or non-voting status. He will issue invitations to persons or installations not directly concerned with USE, permitting attendance at USE meetings, as directed by the Chairman of USE.

Duties (cont.)

The Executive Secretary will maintain files of all USE records and of all official USE correspondence.

The Executive Secretary will also serve as the Chairman of the Publications Committee, and in such position will have the power to refuse to publish or distribute anything through USE channels or under the USE name which does not meet the standards set up by USE.

MEETINGS

Meetings of USE will be held at the discretion of the membership. Each member installation in turn will act as the host for a meeting and will be responsible (1) for providing suitable accommodations, (2) for making housing arrangements or providing information concerning available housing, and (3) for providing a recording secretary, who shall be a stenographer.

GOVERNMENT OF USE

The governing body of the USE organization shall be called the Policy Committee.

POLICY COMMITTEE

This committee shall consist of the Chairman of USE as the chairman and of one representative only from each voting member installation.

Duties

It shall be the responsibility of the Policy Committee to guide the activities of USE into productive channels. If any action of USE does not meet with the approval of the Policy Committee, it may veto such action without recourse to the general meeting of USE.

All meetings of the Policy Committee will be closed meetings except where by a majority vote of the members of the committee they shall be open to the public.

Duties (cont.)

The Chairman will be a non-voting member of the committee.

The Policy Committee will study all ideas submitted in the general USE meeting, especially all suggested changes for existing hardware, and will propose items for consideration either by the general meeting or by any of the standing committees.

All final decisions concerning the USE policy will rest in this committee, and may be changed only by a vote within this committee.

The Policy Committee will meet at the discretion of the Chairman, except that it will convene at each general USE meeting. Any member of the Policy Committee may request a meeting of the committee, whenever he feels that any vote in the general USE meeting should be considered by the Policy Committee.

STANDING COMMITTEES

The size and membership of the standing committees shall be at the discretion of the Policy Committee. The Policy Committee will have the power to dissolve or replace any existing standing committee or add new ones.

Each chairman of a standing committee will make an oral report to the general USE meeting which will outline the subjects discussed and will contain the recommendations of the committee. These reports will be considered accepted if the members of the various committees are satisfied that they are complete and accurate.

The chairman of each committee will submit a written report to the Executive Secretary for distribution to the members of USE. If, upon receipt of the written report of the Chairman, any member of the committee feels that it is incomplete or erroneous in some part, he will communicate directly with the Chairman of the committee, who will submit an amended report to the membership at

<u>STANDING COMMITTEES</u> (cont.)

the next meeting. Acceptance and implementation of any recommendations will require Policy Committee approval.

These committees will normally meet during the period set aside for the general USE meeting, but the Chairman of the committee may call a meeting at any time. However, at least one week's notice must be given to each committee member whenever a meeting is to be held not during a general USE meeting. The meetings of these committees will be open, and invited guests may take part in committee deliberations by direction of the Chairman.

There are at present three standing committees: (1) Program Development; (2) Standards; and (3) Publications.

<u>Program Development Committee</u>

The function of this committee is to study methods of interchange of ideas and techniques. It shall attempt to achieve voluntary cooperation on programs, codes, assignment of work, and to avoid duplication of effort wherever possible.

<u>Standards Committee</u>

The function of this committee is to establish the standards necessary to facilitate the transmittal of programming efforts through USE channels.

<u>Publications Committee</u>

The function of this committee is to set up and maintain proper standards of communication between member installations; to edit all material submitted for distribution under the USE name. In addition, the Publications Committee member from each installation will be responsible for seeing that any material submitted to USE from his installation meets all of USE standards.

VOTING PROCEDURE

Policy Committee Meeting

A quorum of the Policy Committee shall consist of at least 60% of the voting membership. At least 2/3 "yes" and no more than a 1/4 "no" of those present shall be required to pass a motion in the Policy Committee, except that a motion to invite non-member participation shall only require a majority vote.

Standing Committee Meetings

A majority of members present will be necessary to pass any motion in a standing committee.

USE ORGANIZATION MEETING

May 21 and 22, 1956, Holloman AFB, New Mexico

Report of the Program Development Committee

The members of the Program Development Committee were:

Irvin Voltin, RR
Robert Tantzen, HO
Tom Dewey, ML
Tom Dines, RR (representing BA)
Donn Combelic, RW, Chairman

The following persons also attended all or part of the Program Development Committee meeting and participated in the discussions.

Leonard Fall, WADC, Dayton, Ohio
Carl Fluke, WADC, Dayton, Ohio
Owen Hoke, HO
Don Holmes, Shell Development, Emeryville, California
Fred Jones, HO
Peter Lotze, HO
J. M. Moore, Telecomputing (at Holloman)
Elmer Morris, HO
Bob Rich, Applied Physics Lab., Silver Spring, Md.
John Spencer, Office of Corps of Engineers, Wash.,D.C.

The Committee met during the afternoon of the first day and the morning of the second day of the USE Organization Meeting. The agenda for the Program Development Committee as suggested by the Policy Committee included the following points:

1. Progress Reports on coding assignments
2. Report on Tape Handlers by Lockheed
3. Progress on generalized print-edit routines - ML and RW
4. Revision of coding assignments in light of compiler developments
5. Input-Output and Diagnostic Routines

Progress on Coding Assignments.

Common Functions. RW submitted a write-up of a floating-point sin-cos subroutine; RR submitted a write-up of a stated-point arcsin-arccos subroutine. Of the 12 common function subroutines, write-ups of 8 have been submitted to USE. The status of the 4 remaining is as follows: a) Floating-point square root has been coded and checked out by RR; the write-up has not been submitted, b) stated and floating-point log routines have been coded by RR; the write-ups have not been submitted, c) floating-point arcsin-arccos has yet to be completed by RR. None of the common function subroutines submitted by RW have been checked out. The codes have been written in RAWOOP form for checkout on the Serial 9 1103 at St. Paul, as volunteered by RR. When checkout has been completed, RW will incorporate the necessary changes into a final USE write-up.

Numerical Data Output. Boeing has completed the coding of the stated point output routine previously described. The floating-point numerical data output routine, originally assigned to Boeing, has now been re-assigned to Sperry-Rand. Irv Voltin (RR) has coded the number conversion part of this routine--he will follow through on the entire routine, the specifications of which have been described in a previous Program Development Committee Report.

Generalized Output Routine. This worthwhile project has now bounced through three organizations, BA, ML and RW, with little accomplished because of pressure of other projects which have higher priority. Spencer, Army Corps of Engineers, who has had some experience with an Output Editing routine in use at the Army Map Service in Wash., D.C., agreed to send to the secretary of the Publications Committee a copy of the specifications of this routine for distribution to USE members. Spencer will try to obtain enough information from the Map Service to give a report on their operational experience with this routine. Such information should prove helpful to the USE members in setting up specifications for a generalized output editing routine for the 1103A. The visitors from Wright Air Development Center indicated that they may possibly be able to take on the job of producing such a routine for the USE Organization.

Diagnostic Routines. The Program Development Committee had not, up to this meeting, considered diagnostic routines at any great length. The matter was put on the agenda for this meeting. The following points were discussed.

1. Alarm Exit Routine for subroutines. Cook (BA) said that Boeing would be willing to code and write up a relatively simple alarm exit routine. This routine would print out automatically the contents of pertinent cells in a subroutine and also process the exit instruction to indicate the place from which the subroutine was entered.

2. Jump Trace and Memory Dump. Dewey (~~BA~~ ML) has coded these two routines for the 1103A. He will send to Peggy Johnson the writeup of the specifications of the routines.

3. 1103 Diagnostic Routines. Voltin (RR) will study and evaluate the diagnostic routines now available for 1103 computers and report on their applicability to the 1103A.

4. Error Codes. Rich from APL suggested that subroutine Error Codes may be modified by the compiler during compilation so that these codes will provide additional information in the alarm exit print-out. This idea may have application in an advanced version of the compiler.

5. RW will present at the next meeting a critical report of their own operational experience with various 1103 diagnostic routines.

Trans-Use Conversion Program. Holloman has started the coding of what might be called a minimum Trans-Use Conversion Program. A report by R. Tantzen, G. McCrossen and P. Medley, describing the program has been copied verbatim and included as the next page of this committee report. They will continue work on this program and give a further report at the next Program Development Committee Meeting.

Introduction

Trans-Use is a routine which will translate programs written in Use-language into machine language in a format ready for execution or assembly. The compiler contemplated by Use will be a much more powerful instrument capable of doing a variety of functions. For most problems, especially fixed point program, all the features of a compiler will seldom be used. It was felt therefore, that Trans-Use would be a useful instrument even when a compiler is available, especially when it is restricted to do the essential things only.

FEATURES

Trans-Use 1 has the following features:

(1) Translates in a strictly one-to-one correspondence.
(2) Its input is from cards or tape, in Use language.
(3) Output is on cards, giving a side-by-side listing.
(4) The translated program is in a standard format, including a check sum ready for storage on other media.
(5) Assigns binary symbols to standard subroutine symbols, so that a program may refer to these.
(6) Provides information necessary for assembly.
(7) Constants are restricted to B and D integers as specified by Use.

DETAILS

Cards have to be punched as defined by the Standards Committee, except that columns 57-72 are now used for a 4 digit octal address and the 12 octal digit translated word. This reduces the text to 18 characters.

Tape: One line of coding occupies one line of the Unityper copy sheet and therefore also one blockette on the tape. After each field the typist has to type a comma, whether a symbol is present or not. After the text the rest of the blockette is left empty.

Checking: The routine keeps error detecting to a minimum. It will check the sequence of the cards read in as well as the correct number of cards. It will not look for coding and typing errors unless they can be done without much extra coding effort.

Character Codes: The character codes are assumed to be those as requested by Boeing and Use recently.

Program Format for input to Trans-Use is the standard format for Use-subroutines. The lines t-7 and t-6 are not included, as a memory check sum is not known ahead of time. However these 2 cards are punched out. The first line of coding to be entered should contain the absolute octal address relative to which the translation is wanted (usually 1000B).

PROGRESS

The flow charts have been completed. Coding is about 50% complete. We expect to be able to machine check at end of May.

USE Compiler. Pursuant to the directive of the Policy Committee from the previous USE Meeting, ML and RW conferred several times in April and May and were able to agree between themselves on specifications of a Common Compiler for the 1103A. These specifications were presented to the USE Oganization Meeting at Holloman. By a vote of the Policy Committee this compiler was adopted as the USE Compiler.

Part of the Program Development Committee meetings at Holloman were devoted to a discussion of the USE Compiler. One purpose was to apprise the visitors to the meeting of the salient features of the system. It was shown that the Compiler would operate more efficiently with 6 tape units than with the 5 required for the "Standard" 1103A as defined by USE at its first meeting. ML and RW described the progress to date and indicated how they would cooperate toward completing the project. It will be several months before the USE Compiler is operating: by October 1, 1956, it is hoped that a version will be working which will perform most of the functions described in the report on the Compiler which was distributed at this meeting. Additional copies of this report may be obtained from Peggy Johnson (RR). ML and RW will report progress on the USE Compiler at the next USE Meeting.

Revision of Coding Assignments. The bulk of the coding and checking out of the USE Compiler will be done by Lockheed and Ramo-Wooldridge. In light of this, it was decided that these two organizations would complete all coding assignments for USE which they had already accepted, but would not be assigned any other coding projects by the USE Organization.

Miscellaneous. It was pointed out that the coding submitted with USE Subroutines should show, in the comments, the decimal equivalent of constants used in the routine, and further that these values should be the values used in the original formulation times the appropriate scaling factor. Also, the suggestion was made that the cover sheet of all USE Subroutines should show that the subroutine was coded for the ERA 1103A.

The Program Development Committee will meet again July 12 and 13, 1956, in conjunction with the next scheduled USE Meeting in St. Paul with Sperry-Rand acting as hosts.

Donn Combelic, Chairman

1. Expanded test
2. var block for Boing?

~~TENTATIVE~~ AGENDA
USE MEETING
St. Paul, Minnesota
12-13 July 1956

Thursday, 12 July 1956

APL - Bob Rich; P.C. (AP)
Corps of Eng - John Spencer (CE)
WADC - No one present
wd to Request
Zoraars (WF)

8:30 a.m. Policy Committee Meeting (Closed Session)

I. Approval of Minutes of Previous Meeting

II. Consideration of Written Reports of Committee Chairmen

Policy
P.D.
Standards

III. Completion of Agenda

10:00 a.m. General Session

I. Introductions

II. Announcement of Final Agenda

III. Experience with 1103 A

IV ~~III.~~ Discussion from Floor

12:00 Noon Lunch

1:30 p.m. Working Committee Meetings

I. Program Development

A. Progress on Coding Assignments
B. Report on Generalized Print-Edit Routines
~~C. General Mathematical Subroutines~~
C. ~~D.~~ Progress on Compiler
~~D. Algebraic coding report by RR~~

Policy 118
Stds. Spanish Rm
PRW Gold Room
Math Gold Room

II. Standards

A. Exploratory Talks, Diagnostic Routines
~~B. Standards for Writeup and Transmission of Math Subroutines~~
B. Algebraic coding report (R.R)

Concurrent
Informal discussion
math routines

III. Policy (Closed Session)

A. Progress Report, Programming Manual
B. Specifications of Boeing Compiler
~~C. Lockheed Experience with 1103A~~
C. Possible formation of committee for Math subroutines
D. Publication of USE material

Friday, 13 July 1956

9:00 a.m. Continuation of Committee Meetings

12:00 Noon Lunch

1:30 p.m. General Session

I. Oral Reports of Committee Chairmen

II. Discussion

III. Date and place of next meeting.

MINUTES OF THE MEETING OF USE

Minneapolis, Minnesota

12-13 July, 1956

Thursday, 12 July, 1956

I. Policy Committee Meeting, Morning Session

1. The meeting came to order at 8:55 a.m. with the following members present:

R. B. Talmadge (ML), Chairman
D. Cook (BA)
B. C. Dove (ML)
D. Gantner (RW)
J. Mersel (RR)
R. Tantzen (HO)
R. P. Rich (AP)
J. Spencer (CE)

After the introduction of the new members -- Rich (AP), Spencer (CE) -- and the announcement that the third new member organization, Wright Field (WF), would have a representative at the rest of the sessions, the committee considēred the minutes of the previous meeting.

2. Cook (BA) pointed out an error in wording on Line 7 (from bottom), page 1, of the paper "A Statement of the Basic Policies of the Univac Scientific Exchange." The word report should read request. The minutes of the previous meeting, with this change incorporated, were then unanimously accepted.

3. The Program Development Committee Report was unanimously accepted with the following correction by Dove (ML). Line 19 (from bottom), page 2: for Dewey (BA), read Dewey (ML).

4. The Standards Committee Report was read by Cook (BA). There was some discussion of the section regarding execution times, from which it appeared that no one was entirely satisfied with the figure of merit recommended by the Standards Committee. However, the report was accepted unanimously without recommendation.

5. After a spirited discussion of the future of the Standards Committee and the possible formation of a Mathematics Committee, the agenda for the working committee meetings were resolved as follows:

Program Development (open)

A. Progress on Coding Assignments
B. Report on Generalized Print-Edit Routines
C. Progress on Compiler

Standards (open)

A. Exploratory Talks, Diagnostic Routines
B. Algebraic Coding Report (RR).

Policy (closed)

A. Progress Report, Programming Manual
B. Boeing Compiler
C. Committee for Math Subroutines
D. Publications of USE Material

In addition, it was decided that the item "Experience with 1103A" should be discussed in the General Session.

6. A motion for adjournment by Dove (ML) was seconded and carried unanimously at 10:10 a.m.

II. General Session

1. The meeting was opened by the chairman at 10:15 a.m. with an announcement of the addition of three new voting members to the organization.

- Applied Physics Laboratory (AP)
  Corps of Engineers (CE)
  Wright Air Development Center (WF)

2. Helwig (RR) gave a welcoming address in which he summarized the plans of the Remington Rand Univac organization and touched upon the machine delivery schedule.

3. Dove (ML) reported on Lockheed's experience (or rather, lack of experience) with the 1103A. He discussed the failure of the preliminary acceptance test, and the hurried design of further tests for drum, core, tape, and punch.

At this point there was a general discussion from the floor with Helwig (RR) representing the manufacturer.

4. The discussion led to one involving delivery dates and modifications to the machine. At the request of Spencer (CE), the chairman reviewed the procedure for initiating a modification through USE channels.

5. The session was adjourned at 11:30 a.m.

III. Policy Committee Meeting, Afternoon Session

1. The session opened with a discussion by Mersel (RR) on progress with the programming manual. The following points were established:

a. The make-up will be similar to the IBM 701-704 manuals, which are generally recognized as excellent examples of machine explanation for programmers.

b. Because the intent is to enable an experienced programmer to code without other aid, questions of timing, particularly for the peripheral equipment, will be answered completely.

c. There will be a simplified sequential presentation of the instructions in addition to a description of their function.

d. The manual should be completed within three to six months.

Dove (ML) suggested that the USE members could help with proofreading and, perhaps, give suggestions for material. Gantner (RW) concurred except to point out that this might have an adverse effect on the publication date. It was finally agreed that each member installation would see a copy before publication, but that suggestions, while welcome, would be incorporated only at the discretion of the Remington Rand organization.

2. An offer by Mersel (RR) to make the Sperry Rand publishing organization available to USE was discussed. The general feeling seemed to be that the Policy Committee would be happy to have items published from time to time, but that the general publication procedure would remain unchanged.

3. Four people,

R. Zemlin (RR)
J. Rose (RR)
J. Ward (HO)
B. D. Rudin (ML)

who had been holding an informal discussion on mathematical routines were invited to join a similar discussion in the committee.

The chairman read a list of mathematical routines enclosed with the letter from Bauer (RW) and remarked that his impression was that math routines were just the opposite of the kind presented; namely, generalized procedures, rather than particular codes. This feeling seemed general, and the discussion expanded rapidly as the visitors presented the upshot of their previous discussion.

Rudin (ML): The idea of fruitful interchange of ideas can be accomplished by having a limited seminar or colloquium (to run concurrently with USE meetings) on a particular mathematical subject.

Rose (RR): The people involved would be those in each organization most interested and most informed on that particular subject.

Ward (HO): The topic should be selected at least one meeting ahead so that participants would be fully prepared.

These ideas were very well received, and the ensuing discussion brought out the following points:

a. The colloquium (as it was now called) should be for the purpose of interchange of ideas and, if possible, to obtain a set of specifications for routines whose coding was to be supervised by some standing committee of USE.

b. Participation should be limited to two members per organization.

c. The creation of such a colloquium, and the appointment of a chairman, was well within the discretionary powers of the Policy Committee as outlined in the Basic Statement of Policy.

Gantner (RW) was appointed a subcommittee of one to draft a resolution incorporating the above ideas.

4. A discussion of the continued existence of the Standards Committee ensued. Gantner (RW) moved that the committee be dissolved as a standing committee after its presently assigned work was completed. The motion was seconded by Rich (AP) and carried.

5. A motion for adjournment was carried at 4:20 p.m.

Friday, 13 July, 1956

I. Policy Committee (Closed Session)

1. The session came to order at 9:25 a.m. with D. Zonars (WF) present in addition to those of the previous day.

2. Gantner (RW) presented the following motion:

> "There shall be established the policy of holding mathematics colloquia, from time to time at the discretion of the Policy Committee, to meet concurrently with a USE meeting. Each colloquium shall convene to discuss a single subject in the fields of mathematics or numerical analysis, with membership on an individual meeting basis. The purpose of such colloquia is to promote an interchange of ideas, although a desirable product of the discussion is a set of specifications for mathematical routines to be coded under the supervision of a USE committee."

The motion was seconded by Zonars (WF) and carried unanimously.

3. There followed a long discussion of the operations of the working committees and their relationship to the Policy Committee. The general feeling was that the working committees are the backbone of the organization and that the Policy Committee should try to limit its activities to setting the agenda for the working committees, creating new working committees where necessary, and implementing the recommendations of these committees. In this connection, the chairman stressed the point that the agenda problem would be greatly reduced if members would send in items for consideration some time before the meeting.

4. Cook (BA) gave a talk on the specifications of the Boeing Compiler. It appeared that the card-to-tape slant of the compiler would make it awkward for general use by the member organizations. The discussion closed without a recommendation.

5. On a motion by Gantner (RW), the committee voted unanimously to hold the next USE meeting at Los Angeles on October 4 and 5, with Ramo-Wooldridge as the host organization.

6. The meeting was adjourned at 11:00 a.m.

II. General Session

1. The session opened at 1:15 p.m. with an announcement by the chairman of the date and place of the next meeting.

2. The oral report of the Standards Committee was given by McKinley (BA), of the Program Development Committee by Combelic (RW), and of the Policy Committee by Talmadge (ML).

Summaries of these reports are not given, inasmuch as their incompleteness might actually give false impressions of the committee work.

3. The sixth meeting of USE was adjourned at 2:00 p.m.

III. Policy Committee

There was a brief session of the Policy Committee following the close of the General Session. It was decided that a mathematical colloquium should be held at the next meeting on the subject: curve fitting and smoothing techniques. Gantner (RW) was appointed arrangements chairman for the colloquium.

Respectfully submitted,

Bud Talmadge

R. B. Talmadge
Chairman

ATTENDANCE OF THE MEETING

APPLIED PHYSICS LABORATORY

Bitterli, Charles
Rich, Robert P.
Zusman, Fred S.

BOEING AIRPLANE COMPANY

Cook, Don
McKinley, Kenneth

BUREAU OF CENSUS

Heiser, Donald H.

CORPS OF ENGINEERS

Bate, Roger R.
Spencer, John

HOLLOMAN

McCrossen, Garner
Tantzen, R. G.
Ward, James A.

LOCKHEED MISSILES

Dewey, Thomas
Dove, Bernard
Rudin, Bernard D.
Talmadge, Richard B.
Wimberley, Charles

RAMO-WOOLDRIDGE

Combelic, Donn
Gantner, Don
Perkins, Bob

REMINGTON RAND UNIVAC

Albrecht, Norman E.
Bernick, Myrna
Desilets, Philip H.
Etsell, George
Jatso, Betty
Johnson, Peg
Joseph, Earl C.
Krak, Larry
Mersel, Jules
Rose, Jack
Shrake, James
Voltin, I. V.
Wallace, Bill
Wallace, Bob
Wilder, Tom

WRIGHT FIELD

Bauer, F. W.
Fall, Leonard
Petersen, Harry E.
Zonars, Demetrius C.

Talmadge

USE Organization Meeting
July 12 and 13, 1956
Minneapolis, Minnesota

REPORT OF THE STANDARDS COMMITTEE

Those attending the Standards Committee meeting were:

Peggy Johnson, Sperry-Rand Univac Division
Earl Joseph, Sperry-Rand Univac Division
Philip Desilets, Sperry-Rand Univac Division
Myrna Bernick, Sperry-Rand Univac Division
Robert Draving, Sperry-Rand Univac Division
James Shrake, Sperry-Rand Univac Division
W. B. Wallace, Sperry-Rand Univac Division
F. W. Bauer, Wright Air Development Center
Harry Petersen, Wright Air Development Center
Garner McCrossen, Holloman AFB
Jim Ward, Holloman AFB
Fred Zusman, Applied Physics Laboratory
Bob Perkins, Ramo-Wooldridge
C. M. Wimberley, Lockheed Missiles
Kenneth McKinley, Boeing (Chairman)

The meeting of the afternoon of July 12 was devoted to diagnostic routines and a service library.

There was considerable debate as to whether there should be an all inclusive diagnostic routine or many special purpose diagnostic routines.

A proposal was then made that all interested companies submit their ideas on the contents, the standards, and the handling of a service routine library which would include diagnostic routines. These ideas were to be submitted to the chairman for distribution to all members of USE.

This proposal lead to considerable discussion of service routines among those familiar with them, and to many questions from those who are not.

It was then decided that the above proposal would be changed as follows: Earl Joseph would submit to all members a proposal for the standards of a service routine library to be placed in a reserved section on the drum. Members should then send comments, additions, and counter-proposals to Earl Joseph. He would then make a follow-up report to all members before the next USE meeting. The above proposal was accepted by the committee.

The meeting of the morning of July 13 started with a presentation of some notes by Bob Perkins dealing with additions to the USE Compiler subroutine requirements. He stated that a copy would be sent to all members within a few days.

Philip Desilets presented the preliminary specifications of Remington Rand Univac's algebraic coding program. He read through the summary of a document of these preliminary specifications, and also answered questions of the members. Copies of the document were distributed to all members of the committee.

Earl Joseph stated that sentinel blocks are needed at the beginning and the end of fixed block tapes in such things as the USE Compiler, algebraic coding, and tape handling routines. He also proposed a special use of the multiline feature of the high speed printer plugboard to aid in listing algebraic coding and compiling. It was requested that he submit these proposals to all members along with the service routine library proposal.

Kenneth McKinley

Kenneth McKinley
Chairman, Standards Committee

Talmadge

USE ORGANIZATION MEETING

July 16 and 17, 1956

Remington Rand Univac, St. Paul

Report of the Program Development Committee

The following persons attended the Program Development Committee meetings:

Donn Combelic, RW, Chairman
Tom Wilder, RR, San Francisco
Irv Voltin, RR, St. Paul
Bob Perkins, RW
Bob Tantzen, HO
Tom Dewey, ML
Roger R. Bates, CE, Wash.,D.C.
Larry Krak, RR, St. Paul
Bob Wallace, RR, San Antonio
Norm Albrecht, RR, St. Paul
Leonard Fall, WF, WADC, Dayton, Ohio
Bob Simon, RR, New York
Charles Titus, Westinghouse Air Arms Div., Baltimore
Don Heise, Census Bureau, Wash., D.C.
Charlie Bitterli, AP
George Etsell, RR (At BA)

The committee met during the afternoon of the first day and the morning of the second day of the USE Organization meeting. The agenda for the Program Development Committee as suggested by the Policy Committee included the following:

1. Progress on coding assignments
2. Report on Generalized Print edit routines
3. Progress on USE Compiler

Report on Progress on USE Compiler

Two written reports, one on Compiler progress and one on USE Compiler subroutine requirements were presented to the Committee by Robert Perkins, RW. Vellum copies were given to RR representatives for the Publications Committee to distribute as appropriate. After reading these reports and passing out copies to the persons attending the meeting, the reports were discussed along with other aspects of the compiler. Roger Bate, CE, asked about the details of subroutine calling sequence. It was explained by Perkins that a pseudo-instruction calling for a subroutine would be replaced automatically by the Compiler with from one to three instructions depending on the requirements of the subroutine. After some further discussion on subroutines the subject of defining the end points of the USE Compiler was brought up.

After considerable discussion along these lines, the consensus of the group seemed to be that the USE Compiler end points should be defined as far into the compiler as possible. The primary reason for doing this would be to allow the individual installations to develop their own operational procedures with considerable flexibility and still be able to make full use of the USE Compiler. For example, the subroutine library which would be available to the Compiler should be stored on a magnetic tape unit. Just which magnetic tape unit and where on that magnetic tape unit could be decided by each individual installation. Necessary information of this type would be stored (before entering the USE Compiler proper) as a list of parameters in a certain place in core storage or on the magnetic drum. The endpoint of the compiler was agreed to occur after the side-by-side listing tape and binary tape had been produced. At this point the compiler would have finished its job; each installation could then follow with any procedure they wished.

It was pointed out again that the compiler is designed for either five or six tape operation--the six tape operation being somewhat more efficient in that it does not require a second pass over the side-by-side listing tape. In the six-tape mode the binary tape is produced at the same time the side-by-side listing tape is produced; in the five tape mode a second pass over the side-by-side tape is required.

Ramo-Wooldridge agreed to prepare and circulate prior to the next USE Meeting a complete updated report of the specifications of the compiler.

Progress on Coding Assignments

Remington Rand described the general specifications for a floating point numerical data output routine. This has been coded for printing on the off-line high-speed printer. The routine produces 1000 to 1200 lines per minute assuming 8 numbers per line. The program requires 280 storage locations. Speed is gained at the expense of program length. An on-line routine is also being prepared; it will run about fifty instructions less and will be somewhat slower. These subroutines require one parameter word in which the operation part contains the numbers to be printed per line. The u-address part contains the address of the first number in the list to be printed and the v-address part contains the number of lines to be printed. An all zero word prints as a zero in this routine. The question was raised that in the on-line version of the program the number of the tape unit would have to be specified. It was agreed that a second parameter word would contain this information in the v-address part of the word. It was pointed out that the on-line routine would record no information on tape.

Irv Voltin, RR, said that Remington Rand was coding the floating point USE common function subroutines using the built-in floating-point feature of the 1103A. Three of the USE subroutines have not yet been completed, namely the two logarithm subroutine routines, and the floating point arcsine-arcosine. It is expected that these routines will be completed and distributed in the near future.

Report on Generalized Print Edit Routine

It had been agreed at the previous USE Meeting that John Spencer, CE, would provide a written report on a somewhat limited print edit routine in use at the Army Map Service UNIVAC in Washington, D.C. Spencer presented a report on this subject at the committee meeting, a copy of which is attached. He also had a few copies of the formal report on this routine, copies of which were distribution to the member organizations. After the presentation of this report a brief discussion followed and some of the points covered are described here. At the Map Service the tapes to be edited are always rerun, that is, a separate run is made on the tapes for the purpose of editing. This is partly because of the small memory of the Univac Computer. It is possible that on a computer with a larger memory one might be able to compile his own special version of a generalized print edit routine with the main program. A discussion took place concerning how much to use a plugboard on the high-speed printer. It appeared that a generalized print edit routine should assume a one-by-one plugboard. It was pointed out by Spencer that occasionally it is worthwhile to wire a special board and this may save up to half the time in printing. Spencer suggested that the edit routine use a break point in heading blockettes in order to allow back spacing and reprinting of the material whenever this was required. It was agreed that Wright Field and the Corps of Engineers would cooperate on producing specifications for a generalized print edit routine for tape output and that they would report on their progress in this matter at the next meeting of the Program Development Committee.

Diagnostic Routines

Voltin, RR, reported that some of the more common diagnostic routines which were made available through the central exchange for the 1103 computer have now been converted for use on the 1103A. These include the bioctal dump, the flex dump, the changed word dump modified to work on the high-speed printer, and the RW Sampler Routine, which is also being rewritten to work on the high-speed printer. It was pointed out that Convair has an address sorting routine which might possibly be worthwhile modifying for the 1103A. An attempt was made to achieve some type of parcelling out of the work on the diagnostic routines--however, little interest was shown here and about all that came out of the discussion was a rather innocuous agreement that the various installations would keep the members of USE informed at periodic USE Meetings about what diagnostic routines they were working on or plan to work on. It might be pointed out that the agenda called for the Standards Committee to discuss diagnostic routines looking toward possible cooperation on this very important project. RW submitted a writeup prepared by Robert Beach describing the most used trouble-shooting routines at RW along with some editorial comment about their utility and ways in which they might possibly be improved. Copies of this writeup were distributed at the meeting and also have been made available through the Publications Committee.

The Program Development Committee will meet again October 4 and 5, 1956, in conjunction with the next scheduled USE Meeting at Ramo-Wooldridge in Los Angeles.

Donn Combelic, Chairman

MEMORANDUM 11 July 1956

SUBJECT: High Speed Printer Edit

The Army Map Service High Speed Printer Edit is not a general purpose edit routine, however, it handles very adequately a large class of editing problems encountered at that installation. Various subroutines are used to edit the different types of quantities encountered such as latitude, longitude, grid coordinates, etc. Editing is always carried out as a separate run, consequently, the full memory is available for input-output and instructions. There is ample room in the memory for all edit subroutines now in use so they are all read in whether needed or not.

One of the first considerations in writing an edit routine for the HSP is to fix the role of the plug board in printing operations. For a succession of small jobs where the format changes for each job it is preferable to use a one-to-one board and carry out all editing in the control computer. Wiring of special boards for each job slows down the day to day operation. Only one wiring board is used with the AMS HSP paper edit. A special board is used with a special edit routine when very large printing jobs are encountered. This has effected a saving of 50% of central computer time over the regular paper edit. It is not unusual for the running time of the regular paper edit to exceed 2 seconds per block. Unedited data such as memory dumps can be printed in a very convenient form by use of a word edit board and its associated paper loop. Each word is separated by a space, with one blockette to each line. Each block is separated by several spaces.

The edit routine numbers all pages which is a great aid to the printer operator. A fast feed symbol is included in the heading format which homes the paper when a partial page occurs. A printing breakpoint is also included in the heading. When a printing error occurs requiring a rerun of a page, the operator can find the beginning of a page by reading backwards without printing until the breakpoint is reached.

The editing routine completes an output tape at the end of the first full page after 1150 blocks of output are produced. The edit run can be interrupted at any time by depressing a breakpoint and suitable printouts will occur which allows the run to be restarted without loss of previous results. In the case of a machine failure interruption the rerun starts at the beginning of an output tape. If they were redoing the routine they would have the printouts occur at every 200 or 300 output blocks. Since they use a fixed plug board they carry out zero supression in the subroutine rather than through the plug board. Page heading for a given run can be changed only by typing in a new heading at a breakpoint. The AMS routine edits data into fixed columns for a given run. There has been no apparent need for a general purpose routine which will place data anywhere on the page.

JOHN W. H. SPENCER
Corps of Engineers
US Army
ENGBH

1103A - THIS IS A USE PROGRAM
PRINT - STATED DECIMAL - OFF-LINE

I. Purpose:

The purpose of this program is to convert stated binary data to stated decimal and prepare a magnetic tape to cause the printing of the data on the Univac High Speed Printer-Plotter.

II. Method:

A. Each word to be converted to decimal is first made a proper binary fraction by dividing by the appropriate power of ten as indicated by the scale indices. The binary fraction is converted to decimal by repeated multiplications by ten using the integral part of each product to obtain the corresponding Univac coded digit.

When six lines of printing have been converted, they are written on magnetic tape servo number 1 as one block with a blockette and interblock spacing of one inch.

B. This program will print a maximum of 8 eleven digit numbers per line. Approximately 9,000 lines of printing can be contained on one 1,500 foot reel of magnetic tape.

The data must be scaled so that B, the number of binary places to the right of the point, is positive and less than 36. The number of decimal places, D, which may be printed to the right of the decimal point is limited to 10.

II. <u>Method</u>: (Cont'd)

Successive data words to be printed must be in consecutive locations.

III. <u>Usage</u>:

A. <u>Program Entry</u>

The program is entered by basic linkage only by means of the following command:

LOC.	OPERATION	a	v	EXPLANATION
r	RJ	t+2	t	Jump to the first instruction of this program.
r+1	--	--	--	Control is returned here following successful completion of this program.

B. <u>Control Data</u>:

Prior to executing the basic linkage command it is necessary to store the following items of control information:

LOC.	OPERATION	u	v	EXPLANATION
t+3	N	L	M	Format control word. N = number of columns to be printed where 0 N 8 L = location of first data word to be printed. M = number of lines to be printed.

III. Usage: (Cont'd)

B. Control Data: (Cont'd)

LOC.	OPERATION	u	v	EXPLANATION
t+4	--	Do	Bo	Scale indices - one per column to be printed.
t+5	--	Di	Bi	Di = number of decimal places to be printed right of the point where 0 Di 10
'		'	'	
'		'	'	
t+11	--	D7	B7	Bi = number of binary places to the right of the point in the original data where 0 Bi 35

C. Program Results:

This program prepares, on uniservo 1, a magnetic tape containing the data converted to Univac code written in fixed block form at a density of 128 lines per inch and blockettes and interblock spaces of one inch.

This tape, when listed on the Univac High Speed Printer-Plotter, will yield a rectangular array N columns wide and M lines long. Each item printed may contain a total of 12 characters including 10 decimal digits and a decimal point (these may be 11 decimal digits if the item is an integer greater than $10^{10}-1$) plus a sign if the item is negative. No zeros are printed to the left of the most significant digit.

Printing may be accomplished with a standard 120-120 printer panel.

III. Usage: (Cont'd)

D. Input Data:

Data to be printed must be in consecutive locations in the magnetic core or magnetic drum. These data are printed consecutively from left to right and top to bottom.

E. Auxilliary Program Required:

None

F. Program Storage Requirements:

	STARTING LOCATION		NO. OF WORDS	
ITEM	DEC.	OCT.	DEC.	OCT
Program including erasable storage	t	t	322	502
Program without erasable storage	t	t	181	265
Instructions	t	t	157	235
Program constants	t+157	t+235	24	30
Erasable storage	t+181	t+265	141	215

G. Operating Controls:

1. Alarm Exit

This program does not make use of the alarm exit. No error codes are used.

III. Usage: (Cont'd)

G. Operating Controls: (Cont'd)

2. Tape servo number 1 must be ready to accept information written in the fixed block mode.

3. There are no stops within this program.

Remington Rand Univac
DIVISION OF SPERRY RAND CORPORATION

MIDWAY 6-9601

1902 WEST MINNEHAHA AVE.
ST. PAUL W4, MINNESOTA

September 26, 1956

To: USE Members

Subject: Comments on Proposed USE Standards

Enclosed is a digest of the comments received by Earl C. Joseph (RR) of the Standards Committee on a proposal for USE Standards on the topics of Service Library, High Speed Printer Plugboard and Magnetic Tape Handling Methods. This proposal was submitted to the membership for consideration 27 July 1956.

You are again urged to review the original proposal along with these comments.

Leo Kennedy
Leo Kennedy
Information Science Dept.

pb

COMMENTS ON REMINGTON RAND UNIVAC

Proposed USE Standards

I. <u>Service Library</u>:

D. Combelic, (RW)
R. Perkins

In general this seems O.K. and is, of course, quite similar to what we have been using on the 1103. We would suggest, however, that cells starting at 40000 rather than those at 70000 be used for the service routine entrances with 40020 and 40021 replacing 70000 and 70001 as the common exits. (The service routines themselves would be in the 70000 region as you propose.) If these changes were made we believe the system you describe would be completely compatible with a package which we have already prepared for the 1103A. Our package contains many of the service routines which you suggest, namely paper tape input and output, binary card input and output, memory dumps to octal cards and paper tape, a changed word dump (1024 words only), a selective trace, an alarm routine, etc.

Incidentally there should probably be only one diagnostic routine normally entered from library subroutines. A code word would be left in the accumulator if necessary to differentiate among types of errors in one subroutine.

R. G. Tantzen (HO)

The proposed common exit for library routines will have the consequence that two different return jump instructions have to be coded in a program, namely:

RJ	SUB + 2	SUB for subroutines, and
RJ	70000B	SERV for service routines.

This means the programmer should remember both versions and he must know also, whether it is a subroutine or a service routine is referred to.

We feel that prime consideration should be given to ease of programming, therefore, we would prefer having only the first RJ for both cases. The feature of being able to refer to a routine from a program as manually can be saved by placing the two suggested commands inside each routine where this feature is desirable. A suggested arrangement could then be:

70000B + i	MJ	0	BODY	Manual start
SUB	MJ	0	BODY	Program entry
				const. or temp.
	RJ	SUB + 2	SUB + 3	Program exit
	MS	0	70000B + i	Manual exit
BODY				Manual entry
	MJ	0	SUB + 2	Go to exit

We suggest adding another item.

5. Each routine of Service Library, where executed, will not change the memory check sum of the library.

H. E. Petersen (WF)

1. There should be no manually selective jumps or stops in the service library.

2. All options should be controlled by parameter input to routines. These parameters may be entered in Q for manual operation and at the y + 1 address for program operation. We assume the high-speed printer memory dump is an octal dump, and for this we would prefer a parameter selection.

3. The uniform 1024-word high-speed image should be dumped and restored in the entry and exit of the service library.

The proposals for allocation of storage and contents of the library are considered very suitable.

R. R. Bate (CE)

1. Although it may be a good idea, it is not clear how the v address of the MS instruction (1-B-2), which contains the entry address of the last service routine, or the list of starting addresses (1-B-3) is to be used. A more detailed explanation would make possible a better evaluation of your proposal.

2. The service library changed word postmortem memory dump (1-D-2) should permit the option of out-putting only the changed words in a certain section of the MC. Reduction of running time of this routine by this method will make it a much more useful debugging device, especially if used under control of a sampler.

II. High Speed Printer Plugboard:

D. Combelic, (RW)
R. Perkins

Your proposal for single line printing is fine and has, I believe, already been agreed to by USE. We have not given much thought to multiline printing and have no comment on your proposal except to point out that the USE Compiler will not make use of it.

III. Magnetic Tape Handling Methods:

D. Combelic, (RW)
R. Perkins

It would seem advisable to make the blockette of non-printing characters occur in the first (or at least in a fixed) position within the sentinel block. Perhaps this was intended anyway.

R. R. Bate (CE)

1. Magnetic tapes used for temporary storage and not removed from machine should be exempt from the requirements for sentinel blocks.

2. A definite proposal for the character to be used to mark the first and last sentinel block should be made.

3. The proposal that library subroutines do not write on input tapes will result in too complicated and unwieldy subroutines since they must all provide a bypass to this obstacle in the case where the input tape has been replaced on the blocked servo by another tape upon which it is desired to write. This considerable loss of flexibility is too much of a price to pay.

USE Organization Meeting

October 4 and 5

Hollywood, California

The Ramo-Wooldridge Corporation

Arrangements have been made by Ramo-Wooldridge to hold the USE meeting scheduled for October 4th and 5th, at the Hollywood Roosevelt Hotel.

A tentative agenda for the meeting is enclosed. The Chairman of USE, Dick Talmadge, would like to hear from anyone who has additional items he wishes included in the agenda. These items should be addressed to:

R. B. Talmadge
Lockheed Missiles Systems Division
Plant 2, Dept. 66-10
P.O. Box 504
Sunnyvale, California

Leo Kennedy

Leo Kennedy, Executive Secretary
Systems Analysis and Mathematics
Remington Rand Univac

cc: Robert P. Rich, Apllied Physics Laboratory (2)
Donald Cook, Boeing Airplane Company
Randall Porter, Boeing Airplane Company
John W.H. Spenser, Office Chief of Engineers (2)
Marvin Green, Holloman Air Force Base
Robert G. Tantzen, Holloman Air Force Base
Richard Talmadge, Lockheed Missiles Systems Division
Werner Leutert, Lockheed Missiles Systems Division
Donald Gantner, Ramo-Wooldridge Corporation
Walter Bauer, Ramo-Wooldridge Corporation
Leonard Fall, Wright-Patterson Air Force Base
Carl Fluke, Wright-Patterson Air Force Base
Donald Heiser, Bureau of Census
J. B. Rosen, Shell Development Company
Dorothy T. Blum, National Security Agency
Milton Abramowitz, National Bureau of Standards
Jules Mersel, Remington Rand Univac

LBK:mlc

TENTATIVE AGENDA

SEVENTH USE MEETING

4 - 5 OCTOBER 1956

I. Place: Hollywood Roosevelt Hotel, Hollywood California.

Host: Ramo-Wooldridge

II. Time Schedule

Thursday, 4 October 1956

A. Policy Committee (Closed), 8:30 A.M.

B. General Session, 10:00 A.M.

1. Introductions

2. Announcements , A4

C. Lunch, 12:00 Noon.

D. Working Committee Meetings, 1:30 P.M.

E. Colloquium (Restricted), 1:30 P.M.

Friday, 5 October 1956

A. Working Committee Meetings, 9:00 A. M.

B. Colloquium (Restricted), 9:00 A.M.

C. Lunch, 12:00 Noon.

D. Policy Committee (Closed), 1:00 P.M.

E. General Session, 3 P.M.

1. Oral reports, committee chairman

2. Remarks by Colloquium Chairman

3. Announcements

III. Items for Committee Consideration

A. Administrative

~~1.~~ Time and Place of Colloquium talk - Dr. George Forsythe (RW) Gen session @ 11 o'cloc

~~2.~~ Approval of Minutes.

✓3. Progress Report on Programming Manual - Mersel (RR)

TENTATIVE AGENDA (Continued)

4. Question period on 1103A.

5. Establishing an installation mailing list for distribution with the minutes.

6. Future plans of USE.

7. Date and Place of next meeting.

8. Sponsorship of meetings (DUE MC for HS (orig))

9. distribution of USE material & pub

10. organizational obligations (PDC)

B. Compiler

1. Bate (CE): Proposed changes to USE Compiler

   a. Permit subroutines to refer to other subroutines.

   b. Permit use of L(C) in subroutines or establish a constant pool of commonly used constants.

   c. Subroutine temporary storage pool of required length which can be shared by all subroutines in a compiled routine.

   d. Names of subroutines to be two character installation code and four alphanumeric characters instead of USExxx.

2. Question Period on USE Compiler.

3. Presentation of Boeing Compiler, Cook (BA)

C. Machine Modifications

1. Bate (CE):

   a. Provision of open ended right shift of A or A and Q registers.

   b. Reversal of the Index Jump instruction (so that jump occurs when D(U)-1 is negative) to permit easier pretesting of loop repetitions and so that loop repetitions of zero times are possible.

   c. Transmit Operation Instruction.

   d. Change Sign Jump and Zero Jump to one way jump by bringing (U) into A before testing, jump to V if (U) is positive or zero respectively.

   e. Instruction to permit storing parts of the A register:

   Word consisting of bits A_{71}, A_{69} - A_{35};

   Word consisting of bits A_{71}, A_{34} - A_0.

TENTATIVE AGENDA (Continued)

Would like these words addressable but would be satisfied if stored as part of the Left Transmit Instruction with j = 2, 3.

f. An option under control of the External Function Instruction than an overflow condition is indicated and the machine responds by getting the next address from fixed address F_4 or by stopping, depending on a console switch setting. This change to affect Replace Add, Replace Subtract, Add and Transmit and Subtract and Transmit when A_{71} is not equal to A_{35}.

2 Gasen (HO):

a. absolute jump (Gassen HO).

b. fixed address for all zero word.

✓D. Auxiliary equipment

1. verifier
2. compatibility of unitype & line printer

✓E. ~~Proposed~~ USE ~~standards~~ programming topics

1. H.S. printer ~~& playboard~~.
2. mag tape handling methods
3. Service library

MINUTES OF THE MEETING OF USE

Hollywood, California

4-5 October 1956

Thursday, 4 October 1956

I. Policy Committee Meeting

1. This meeting was called to order at 8:30 a.m. with the following members present:

R. B. Talmadge, (ML), Chairman
R. P. Rich (AP)
D. I. Cook (BA)
B. C. Dove (ML)
D. Zonars (WF)
E. Joseph (RR)
J. W. H. Spencer (CE)
D. W. Gantner (RW)
M. Green (HO)

The Chairman read a telegram from George Clark of the Operations Research Office of Johns Hopkins University, requesting voting member status and a proxy vote, through Rich (AP), at the meeting. After some discussion, the Committee decided that proxy voting was contrary to the spirit of USE as expressed in the document of 22 May 1956; and that the JHU-ORO should request voting member status by the regularly established procedure.

2. The remainder of the session was devoted to establishing the agenda. The final result was as follows:

A. General Session, Thursday, 10:00 a.m.
  (1) Introductions
  (2) Announcements
  (3) Question Period on 1103A
  (4) Colloquium Talk - Dr. George Forsythe

B. Machine Modifications Committee, Thursday, 1:30 p.m.
Special Committee, Chairman: Bate (CE)
  (1) Computer Modifications
    (a) Open ended right shift of A or A and Q
    (b) Reversal of Index Jump Instruction
    (c) Transmit Operation Instruction
    (d) Modification of Sign Jump and Zero Jump
    (e) Partial Store of A Register
    (f) Modification of Present Machines Response to Overflow
    (g) Fixed Address for an All Zero Word
    (h) Absolute Jump Instruction
  (2) Auxiliary Equipment
    (a) Tape Verifier
    (b) Compatibility of Unityper and High Speed Printer

C. Program Development Committee
Thursday, 1:30 p.m. and Friday, 9:00 a.m. Chairman: Combelic (RW)
  (1) Review of Organizational Obligations
  (2) Discussion of USE Compiler
    (a) Comments
    (b) Progress

(3) Presentation of Boeing Compiler, Cook (BA)
(4) Use of Peripheral Equipment
(5) Generalized Print Edit Routine

D. Programming Topics Committee
Friday, 9:00 a.m. Special Committee. Chairman: Joseph (RR)
(1) Magnetic Tape Handling Methods
(2) Service Libraries
(3) High Speed Printer Plugboard - Standard?

E. Policy Committee. Friday, 1:00 p.m. (Closed)
(1) Approval of Minutes
(2) Progress Report on Programming Manual, Kennedy (RR)
(3) Distribution of Installation Mailing List
(4) Date and Place of Next Meeting
(5) Proposal to Have Remington Rand Univac Host All Meetings
(6) Review of USE Distribution and Publication Procedures
(7) Future Plans of USE

F. General Session. Friday, 3:00 p.m.
(1) Oral Reports, Committee Chairmen
(2) Remarks of Colloquium Chairman
(3) Announcements

Following the basic idea expressed in the motion of formulation, no attempt was made to set an agenda for the Colloquium.

II. General Session

1. The session was called to order at 10:15 a.m. After introductions, the agenda was read by the Chairman.

2. Helwig (RR) took the floor to answer questions on the 1103A equipment and auxiliary equipment.

Q. (Anon) What is status of tape verifier?

A. About a year away.

Q. (Perkins, RW) How is the Unityper to be modified to be compatible to the high speed printer?

A. Pads on keys to be changed so that keyboard is non-standard except for letters and numbers.

Q. (Anon) What is procedure for getting specific information about machine operation?

A. Through local representative. Steps have been taken to improve communication, and to avoid unfortunate misunderstandings which have sometimes arisen in the past.

3. Dove (ML) reported on the status of the Lockheed machine. In essence, he stated that the machine was still undergoing extensive acceptance tests three weeks after delivery. The drum and core appeared to be in excellent shape, but

the tapes required more work. The non-diagnostic acceptance tests programmed by Lockheed will soon be made available to all members of USE.

4. At 11:00 a.m. the session was turned over to Young (RW), the Chairman of the Colloquium. Dr. Forsythe (RW) was introduced as the Colloquium keynote speaker. The talk, on "Generation and Use of Orthogonal Polynomials for Approximating Functions" was thoroughly enjoyed by all present.

5. The session adjourned for lunch at 12:00 noon.

Friday, 5 October 1956

I. Policy Committee Meeting

1. The meeting was called to order at 1:30 p.m. The attendance was the same as the previous session except that Combelic (RW) replaced Gantner (RW), and no member from HO was present. On a motion by Rich (AP) and a second by Cook (BA), the minutes of the Sixth Meeting of USE, held at Minneapolis on 12-13 July 1956, were unanimously accepted.

2. The idea of an official installation mailing list was unanimously approved. The Executive Secretary, Kennedy (RR), will distribute copies as soon as they are available.

3. Discussion on the date and place of the next meeting centered around the fact that, for the first time, Committee recommendations had been presented to the Policy Committee for their action prior to the end of the meeting. The general feeling seemed to be that a three day meeting might allow the Policy Committee time to act on such recommendations, thus saving months of time on items which seemed urgent. Spencer (CE) pointed out, however, that some organizations might be able to send fewer people to a longer meeting. Finally, a trial three-day meeting was decided upon, with the Applied Physics Laboratory of Johns Hopkins University to act as Host Installation for the Eighth USE Meeting on 9-11 January 1956, at Washington, D. C.

4. The offer of Remington Rand Univac Sales to act as host for all the USE meetings was considered with somewhat mixed feelings. The membership liked the idea of a central arrangements group and agreed that Univac Sales was the logical choice. There was no serious objection to using the USE organization for sales promotion, provided that no sales talks were given in USE meetings, and that the Univac Sales Department exercised no power over the attendance at the meetings. With this basic agreement, it was left to the Chairman to write the motion and submit it to the membership for telegraphic vote as soon as possible. The results of this procedure are covered in the Appendix.

5. Upon a review of the publication standards of USE, two amendments were made:

A. Each installation shall receive five (5) copies of documents instead of the present three (3); and these copies shall be sent to members of the Publications Committee.

B. A category of publication called USEful Notes was established. These are to be items other than subroutines which members feel are of general interest to the organization. They will be numbered serially by the Executive Secretary as they arrive and will be distributed unedited. By a vote of 6 yes, 1 abstain, the Policy Committee decided to eschew use of the Central Exchange for USE material.

6. The Executive Secretary, Kennedy (RR), reported on the progress of the programming manual. A lively discussion of the contents and format ensued, from which it appears that the first draft, available for editorial comment by the members some time after 1 December 1956, may undergo considerable revision.

7. The special report of the Colloquium Chairman, Young (RW), was read to the Policy Committee by the Chairman. This report is essentially that given below as Minute 4 of the General Session. The Policy Committee was very much impressed with the apparent success of the Colloquium, as well as the prompt submittal of recommendations. It was felt that there was not enough time to study the recommendations at the present meeting and action on most items was deferred until next time. However, the recommendation of a colloquium at the next USE meeting on the subject, "Spectral Analysis" with Ward (HO) as Chairman was unanimously adopted.

8. The report of the Machine Modifications Committee, Bate (CE), Chairman, was read by the Chairman. This report is essentially that of Minute 2 of the General Session. Action on the recommendations was as follows:

A. By a unanimous vote, direction to Bate (CE) to write a letter for all members' signature requesting correction of unsatisfactory behaviour of machine when a "not ready" servo is referenced.

B. A vote of 6 yes, 1 abstain, direction to Bate (CE) to write a letter for all members' signature requesting high priority to investigate modification of computer behaviour on overflow.

C. By a vote of 6 yes, 1 abstain, direction to Bate (CE) to write a letter for all members' signature requesting investigation of:

(1) An instruction to transmit the u-addresses portion of u to the v-address portion of v, and its counterpart instruction, the transmission of the v-address portion of u to the u-address portion of v, both without disturbing the remainder of (v).

(2) An instruction to change abnormal drum setting to normal drum.

9. The meeting was adjourned at 3:05 p.m.

II. General Session

1. The session was called to order at 3:15 p.m. Talmadge (ML) read the report of the Policy Committee.

2. Bate (CE) reported as Chairman of the Machine Modifications Committee. Sixteen modifications to machines were discussed and put into three categories; (A) Essential, (B) to be investigated, and (C) recommend no action.

A. Essential

(1) Change present behaviour of machine (a fault occurs) when uniservo in not ready status is referenced.

(2) Modify machine response to overflow.

B. To be investigated.
(1) Allow drum to be set from abnormal to normal under program control.
(2) Instructions to transmit u-address to v-address and vice versa.
(3) Q-controlled equality jump.

C. Eleven modifications were read under the category: No action recommended.

3. Joseph (RR) reported as Chairman of Programming Topics Committee

A. The service library should occupy group 4 of the drum.

B. No action recommended on entrance and exit lines.

C. Service routines should not use selective jumps or stops. (other than 0).

D. High speed printer board left as before.

E. Recommended list of service routines:
(1) Selective trace
(2) Hierarchy trace
(3) Jump trace
(4) Memory dump
(5) Input-output routines
(6) Tape handling routines
(7) Some diagnostic routine, such as changed word post-mortem.

4. Young (RW) reported as Colloquium Chairman.

A. The Committee recommends that the method for curve fitting, as outlined by Dr. Forsythe, be studied and a USE program be prepared for the 1103A. The mini-max program, presented by Dr. Curtis, which is now in the repertoire of of the Ramo-Wooldridge Corporation 1103 library, should be prepared for use on the 1103A.

B. Colloquium also unanimously recommends:
(1) Colloquium be made a permanent committee called Mathematics Committee and meet concurrently with the regular USE organization.
(2) A Chairman be selected.
(3) At least one permanent member be assigned to the committee by each installation.

C. Recommendations for the functions of the Mathematics Committee:
(1) To make recommendations to USE and member installations regarding mathematical routines which are desirable. This should include suggestions as to:
(a) Method adopted
(b) Numerical procedure employed
(c) Testing procedure for checking validity of the routine
(2) To make recommendations for research and development of new methods.
(3) To report on development of new methods in the literature or new experiences in the representative installations.
(4) To conduct discussions concerning types of problems being

currently solved in each installation with a view of exchanging experience in regards to method employed and results obtained.

(5) To set up programs for each USE meeting, for itself and also for a possible general presentation to the entire group. This should promote an interchange of ideas on the particular theme selected for that meeting through informal discussion.

D. The Committee would like to look into the development of standards for mathematical subroutines which would promote compatibility in their usages. For example, two distinct methods for doing a particular problem should be prepared in a way so that the calling sequence and that of presentation to both are equivalent.

E. The following topics are recommended for consideration for the next few meetings:

(1) Ordinary DIFFERENTIAL EQUATIONS
(2) Partial Differential Equations (parabolic, hyperbolic, elliptic)
(3) Monte Carlo methods
(4) Spectral analysis
(5) Eigenvalues of non-Hermitian Matrices
(6) Solution of non-linear systems and determination of extremum.

The Committee recommends the following order of interest in the topics for the next two meetings.

(1) Spectral analysis
(2) Ordinary Differential Equations

F. The Committee recommends Dr. James Ward as temporary chairman for the following meeting, and Werner Frank as secretary.

5. Combelic (RW) reported as Chairman of the Program Development Committee.

A. The Boeing Compiler is 50% coded. They are going to a magnetic tape operation.

B. USE Compiler - Points of Note

(1) 50% coded
(2) Generalized diagnostic routine being worked on.
(3) Some thought given to input-output generator.
(4) Should be in relatively good shape by December 1.

C. Organizational obligations reviewed. At least thirteen (13) routines should be checked out by next USE meeting.

D. On the high speed printer generalized edit routine it was agreed that WF, CE and AP would meet in Washington D.C., around 1 November. After this Bate (CE) will meet with ML, RW, and BA at Palo Alto to try to determine specifications for a routine satisfactory to all.

6. The Seventh Meeting of USE was adjourned at 4:45 p.m., 5 October 1956.

Respectfully submitted,

RBTalmadge

R. B. Talmadge, Chairman

Appendix

Since the proposal to have a Remington Rand Univac Sales as host of all meetings would change the basic operational procedure of USE, the motion was submitted by the Chairman to the Policy Committee members in the form of revisions to the document of 22 May 1956 entitled, "A Statement of the Basic Policies of the Univac Scientific Exchange". These read as follows:

Page 1: Delete the last paragraph, which reads, "Visitors may be . . . to a committee.". Substitute the following:

Visitors may be invited by any voting member installation and by the Remington Rand Univac Scientific Sales Department, St. Paul, Minnesota. (Hereinafter called RR-Sales.) The number of invitees, and, if possible, their names and organizational affiliation, must be submitted to the chairman and RR-Sales prior to the meeting which they are to attend.

Only the Chairman, upon a specific vote by the Policy Committee, will have the power to limit the number of invitations or to defer attendance of a duly invited person.

Page 3: Add the following sentence to the last paragraph defining the duties of the Executive Secretary:

In this capacity, he will make available to RR-Sales, to use as they see fit; membership lists of the USE organization; specifications and descriptions of routines which are available to members of USE; and such other items as the Policy Committee may, from time to time, direct.

Delete the paragraph under the general heading, Meetings. Replace it by the following:

Meetings of USE will be held at the discretion of the membership. RR-Sales will serve as host for all meetings, and will be responsible (1) for arranging assembly committee meeting facilities, (2) for alerting hotel facilities for reservations, and (3) for providing such other services as they deem necessary or desirable in order to facilitate the course of meetings. Each installation will be responsible for submitting the number, and whenever possible, the names of their representatives to RR-Sales prior to each meeting.

In addition to the host, each member installation in turn will act as Host Installation, and will be responsible for providing a recording secretary, who shall be a stenographer.

The covering letter pointed out that the telegraphic vote was essentially on the basic idea, since wording changes could be made by the Policy Committee at any meeting.

As of 14 November the vote stood at 7 yes, 1 not heard from, which carries the revisions.

REPORT OF THE AD HOC COMMITTEE ON MACHINE MODIFICATIONS

The Ad Hoc Committee on Machine Modifications met at 1330, 4 Oct 1956. The following persons were present:

R. Bate, CE, Chairman
R. Talmadge, ML
B. Dove, ML
G. Garner, HO
E. Jospeh, RR
T. Wilder, RR
A. Stone, APL
D. Heiser, Census Bureau

A discussion of fifteen proposed modifications took place and it was decided to recommend to the policy committee that the USE members sign and send to Remington Rand a letter requesting that two of these changes be made and that three others be investigated to determine feasibility, cost, and time required. A draft of such a letter is enclosed with these minutes.

In addition to the five modifications which are listed in the draft letter the following modifications were considered but the consensus of opinion was that either the modifications would be very expensive or that there was not sufficient use for the instruction to justify any further action at this time.

1. Each fixed address should be used by only one instruction. At present the repeat instruction and the interpret instruction both use F_1. This difficulty can be avoided at the expense of one additional instruction at the beginning of an interpretive routine to store F_1, in case the interpretive routine will contain a repeat instruction.

2. 2. The repeat instruction should permit incrementing of the U- and V-Address of the next instruction by any amount, positive or negative. Although this is a desireable feature it is likely to be very expensive since two additional 15-bit registers are required to hold the U and V increments and UAK and VAK would have to be adding registers.

3. A generalized repeat command which repeats several of the following commands incrementing the U and V Address of each by specified amounts. This modification is of only moderate use and is likely to be extremely expensive.

4. An open-ended right shift of A and Q Registers. This is an extremely useful instruction in most fixed point calculations., especially in the evaluation of such expressions as $\frac{ab2^{-P}}{C}$ which is most unhandy and slow at present. Such a modification is likely to be difficult.

5. Permit partial write into A and Q. This instruction is of limited use.

6. An additional instruction for transmitting the operation part of a word analogous to TU and TV instructions. This instruction is of very limited use.

7. Considerable discussion of changes in sign jump occured but no conclusive recommendations were made.

8. Reversal of Index Jump so that jump occurs when D(u)-1 is negative, so that more convenient pretesting of loop length can be made. It was pointed that this does not make pretesting easier as is shown in the following example using the index jump as it is present. It is recommended that this example or a similar one be included in the programming manual, showing correct use of the index jump in pretested loops which are to be traversed N times ($N \geq 0$).

1A	TP	N	K
	MJ	0	1B
LOOP	X		
	X		
	X		
	X		
1B	IJ	K	LOOP

9. An absolute Threshold Jump so that a jump to V occurs if $/(u)/>/(A)/$. This additional instruction is of limited use.

10. An address (say 30000) which permanently contains zero. Since it would be necessay for the computer to stop on a fault if an instruction tried to change the contents of this register, this is likely to be complicated and it is surely easy to store a zero in the memory.

11. Add to the left transmit instruction:for j=2 to store a word consisting of $A_{71}, A_{35} \ldots\ldots A_0$ and for j=3 to store a word consisting of $A_{71}, A_{35} \ldots\ldots A_1$. These instructions would be useful in double precision arithmetic since the j = 2 instruction stores the second 35 most significant bits of the A register together with sign when $A_{71} = A_{70}$ and the instruction for j = 3 does the same when $A_{71} \neq A_{70}$. It did not appear that double precision work was sufficiently common for USE to take any further action at this time.

Roger R. Bate

INCL: Draft letter to
Remington Rand

ROGER R. BATE
Captain, Corps of Engineers
Chairman

DRAFT LETTER

Remington Rand Corporation
Engineering Research Associates Division
1902 Minnehaha Avenue
St. Paul 4, Minnesota

Gentlemen:

We request that you correct the following unsatisfactory behavioe of the Univac Scientific Computer (1103A):

1. At present the computer stops when a division or multiply add overflow occurs, which is not in accordance with accepted principle that no error which is reparable under program control should stop the computer. It is suggested that when either of these overflows occurs that the computer find its next instruction in a fixed address (probably F_5), without altering PAR. This procedure would be like the program interrupt except that the next instruction is found in F_5 instead of F_3. An alternative procedure would be to advance PAK by one, thereby causing the computer to skip an instruction in case of overflow.

2. At present when a uniservo which is "not ready" is referenced in an external function instruction, this instruction is not executed and the computer continues until a computer fault stop approximately 80 milli= seconds later. Since some 2,000 instruction may be performed during this time it is likely to be extremely difficult to restore the memory and the tape positionsto the state that existed prior to the execution of the external function instruction which caused the fault, a procedure which would be necessary in order to restart the program after correcting the "not ready" condition. Since many problems require the changing of a tape while the computer is running in order to save time, this condition might be expected to occur rather frequently. It is suggested that the "not ready" condition set up a si nal similar to that set up when a servo is rewinding so that the computer idles until the "not ready" condition is corrected and then resume.

In addition we request that you investigate the feasibility, cost, and time required for the following modifications to the 1103A Computer:

1. An additional instruction to transmit the U-address portion of (U) into the V-address portion of V; both leaving the other portions of (V) undisturbed.

2. An additional instruction to change the Abnormal Drum setting to Normal Drum but not the reverse.

3. An additional instruction, which might be called the Q-Controlled Equality Jump, which jumps to V if L(Q)(u) = A and continues the normal sequence if not; (A) to be restored to its initial state in either case.

Sincerely yours,

REPORT OF THE ADHOC COMMITTEE ON THE GENERALIZED
OUTPUT EDIT ROUTINE FOR HIGH SPEED PRINTER
(Eastern Branch)

The committee convened on Tuesday 30 October 1956 at 9:00 O'clock. In attendance were: Captain Roger R. Bate, Corps of Engineers, Chairman

Mr. Richard Petonke, Corps of Engineers,

Mr. Robert Miller, Corps of Engineers,

Dr. Bruce Taylor, Operations Research Office,

Mr. Stephen Warshall, Operations Research Office,

Mr. Charles Bitterli, Applied Physics Laboratory,

Mr. Leonard Fall, Wright Air Development Center.

Mr. John W. Spencer, Corps of Engineers, was in attendance during part of the session.

The chairman opened the discussion with a short resume of the discussions which had taken place at the USE Committee meeting in Los Angeles. He pointed out that the two proposed edit routines, one from Wright Air Development Center, which emphasized a large number of parameters to specify format and one from the Corps of Engineers which was a micro program treating each character separately, had met with a somewhat luke-warm reception. The chairman further discussed the suggestion by Mr. Don Cook of Boeing Air Craft at the USE meeting, that format might be described by giving a sample line consisting of 120 characters, each character representing either a space or the type of conversion for the number which should occupy that space.

It was decided to offer the Corps of Engineers High Speed Edit Routine, which might be more appropiately named, a Printer Output Routine to the USE organization, in view of the fact that it has already been coded by the Corps of Engineers. Since this routine is of general power it will serve in cases which might not be covered by another routine, which we proceeded to discuss. The two possible methods of laying out formats were the sample line format of Don Cook and the parameter format favored by Wright Air Development general center. It was quickly realized that the sample line concept involved not only the writing of a sample line, but also must include certain parameters to describe such things as how many times the line should be repeated, where the Binary information for each word on the line is stored, and, in the particular case of stated binary point to stated decimal point conversions, provision must be made for giving the number of significant digits to the right of the decimal or binary point. These additional parameters somewhat complicate the rather desirable features of the sample line format description and probably make it very unwise to go further in this line. For that reason the discussion turned to the parameter format description which Wright Field had proposed. The principle objections in Wright Field's Parameter description was a rather complicated scheme, that might require the writing in a large number of parameter words in order to do a fairly simple editing process. The discussion then turned to methods which could be used to make the parameters more descriptive and easier to use. A concept which emphasized more strongly the column in format was proposed.

Certain general principles were agreed upon. One, that the Edit Routine should take the binary input data from the magnetic core or possibly from the magnetic drum in the editing process. The Edit Routine should not involve reading input data from magnetic tape. This process would be accomplished by the programmer in the main routine. Two; several different means of converting binary information for output such as straight alphanumeric, octal print out, stated binary to stated decimal point, floating binary to floating decimal as one or two word items, and double precision stated point or floating point conversions should be permitted. In addition some consideration was given to the possibility of providing for various other kinds of conversions at the Coders convenience. Such thing as radians to degrees, minutes, and seconds or geographical coordinates to UTM coordinates or other specialized conversions would be desirable provided they could be worked into routine without requiring too much space. The meeting adjourned until Wednesday, 31 October, 9:00 O'clock.

The members were to consider the matters which had been brought up at this meeting and to be prepared to draw a fixed set of specifications for the parameter format type of Edit.

The meeting of the High Speed Edit Routine Committee resumed at 9:00 O'clock on Wednesday 31 October. The minutes of the preceding day's meeting were approved unamimously.

Captain Bate presented for discussion a specification for a High Speed Printer Edit routine based upon the use of parameter words describing the format. The major objections which appeared during discussion of this routine was the necessity for storing the binary and decimal scaling factors with the binary input information for stated point binary to stated point decimal conversions. It was believed that it would be more appropiate for this information to be in the format parameter.

A new set of parameter specifications was drawn up to include this feature and to remove the necessity for reassembling all of the binary output pertinent to one line in one place. Instead, the parameter for a column contained the address where the binary information for that column began. Some discussion was given to the question of modifying this routine for those machines which have the on-line printer or which have the variable block option on the tape units. It was decided that separate routines could be written which would be very similar, so that the work for writing three would be very little more than that for writing one.

The final specifications were unanimously approved and it was decided that the chairman offer to the Western Branch, these specifications for a routine which has parameter specified format and also for the Corps of Engineers character Edit Routine which has already been written. This combination, it is thought, will provide for the most general types of output which can be encountered. Mr. Leonard Fall of Wright Air Development Center committed his organization to the writing of a High Speed Edit which is based on specifications not too different from those specifications which were agreed upon for the parameter specified format routine. He pointed out that his organization would not be able to undertake any Edit routine which was much more ambitious than this one.

The meeting adjourned at noon.

ROGER R. BATE
Captain, U. S. Army, Chairman

Talmadge

USE ORGANIZATION MEETING
October 4 and 5, 1956

REPORT OF THE AD HOC COMMITTEE ON PROGRAMMING TOPICS

Among others the following people attended the committee meeting:

Dick Talmadge (ML)
B. C. Dove (ML)
Garner McGrossen (HO)
Sue Knapp (RW)
Dick Petonke (CE)
D. Heiser (Census)
Joseph Wegstein (Bureau of Standards)
Frank Kros (RR)
Leo Kennedy (RR)
Earl C. Joseph (RR) Chairman

The meeting of October 5 was devoted primarily to discussions concerning the service library.

There was considerable debate on many items with no conclusions being drawn; therefore, this report will concern itself with only those ideas or suggestions which resulted in a conclusion. In most cases these conclusions are in the form of suggested methodology rather than strict standards to be followed by the USE organization.

Service Library

For consistency in transferring and use of large programs such as the USE compiler, algebraic coding schemes, service libraries, etc., it was felt necessary to reserve group 4 on the drum for the service library.

In order to use service routines for all types of programs, the MS and MJ instructions with j values other than zero should not be programmed to obtain the various options. Therefore, if it were desirable to program routines with options, a parameter should be placed in the Q-register which is in turn decoded in the service routine to obtain the options. However, in no case should the service routine be written in such a manner to require that the parameter word follows the Return Jump which was used to enter the service routine.

Each service routine should operate from magnetic core. Therefore each routine should be written to dump the portion of MC used on to a drum image (contained in the service library) before the routine is bootstrapped into MC and to restore the constants of MC used from the drum image before exit.

Contents of Service Library

The following routines were suggested as the minimum service library:

1. Trace Routines

   a. Select area to be traced
   b. Select type of record and what recorded
   c. Select # times loop recorded and/or traced
   d. Hierarchy trace

2. A memory dump

3. Some form of a changed word post mortem routine. It was suggested that this routine should be like a memory dump with an ID (probably a star) for those words which have changed.

4. Input routines for:
   a. Magnetic tape
   b. Cards

   It was the consensus of opinion that most users would not need paper tape routines after they had their respective installations on the air. ~~Dick Petonke of Corps of Engineers stated that they would depend heavily upon paper tape.~~

5. Simple output routines for:
   a. Magnetic tape
   b. Cards

6. Numerous other error diagnostic routines were discussed and felt necessary but no conclusions were reached.

<u>Magnetic Tape Handling Methods</u>

Due to the lack of time, this subject for discussion was only touched upon. It was felt that the following tape routines would be useful additions to the library:

1. A routine to duplicate tape

2. A tape merge

3. A tape search routine

Earl C. Joseph
Chairman, Ad Hoc Programming--Topics Committee

Talmadge

Proceedings of the Mathematics Committee COLLOQUIUM of the USE Organization

The Mathematics Committee, under the chairmanship of Dr. David M. Young, was in session on Thursday and Friday, October 4-5, 1956, during the regular meeting of the USE organization in Los Angeles, California. The following persons participated:

Jim Price	-	Boeing
Harry Shaw	-	A.P.L.
Joe Carlson	-	Lockheed
Richard Zemlin	-	Remington Rand (St. Paul)
Jim Ward	-	Holloman
Harry Davis	-	White Sands (observer)
Marvin Green	-	Holloman
Werner L. Frank	-	Ramo-Wooldridge Corp.
David M. Young	-	Ramo-Wooldridge Corp.

The speakers were Dr. George Forsythe and Dr. Philip Curtis. The Corps of Engineers and Wright Field did not have sufficient personnel present to participate but did indicate an interest in these sessions. The agenda for the sessions is given in Appendix A.

Thursday

The program began with the keynote presentation of Dr. George Forsythe speaking on "Generation of Orthogonal Polynomials". This fine talk was given to the entire USE group. In summary, the main thesis was that the usual least squares procedures for curve fitting be replaced by the method of orthogonal polynomials. This has at least three distinct virtues:

1) Avoids the inversion of a possibly poor conditioned matrix which in some cases behaves like a Hilbert matrix

2) Permits the calculation of successively higher order polynomial approximations by requiring only a simple computation when going from the n^{th} to the $(n+1)^{st}$ stage. In the normal least square problem an entirely new linear system would have to be solved.

3) Allows the use of a three term recurrence relation to evaluate the orthogonal polynomials. Some copies of this report will be made available to the Policy Committee. Request for other copies can be made directly to Dr. George Forsythe at the University of California at Los Angeles.

Dr. Philip Curtis presented the second paper on "Curve Fitting by a Mini-Max Technique". A constructive procedure was outlined for finding the polynomial of best approximation, for given degree, according to the criterion that

$$\max \left| F(x) - P_n(x) \right|$$

be minimized. The resulting error function $F(x) - P_n(x)$ will oscillate with equal amplitudes. A summary of this talk and a bibliography is included in Appendix B. This material together with a description of the Ramo-Wooldridge curve fitting routine was distributed at the meeting.

The discussion which followed was:

1) Difference between smoothing of date and curve fitting. The least squares procedure can be looked upon both as a smoothing technique and as a way to fit curves. However, the mini-max procedure assumes exact analytic data and does no smoothing. Therefore, when fitting empirical or experimental data is to be done the least square is usually more desirable than the mini-max procedure.

2) The following methods are used by the attending installations in approximating the elementary functions:

a) formulas of Hastings (most popular)

b) rational approximations due to Kogbetliantz (Boeing)

c) Taylor Series (White Sands)

Continued fractions do not seem to be used. It was also pointed out that formulas which use the least number of divisions are best for the 1103A while for the 704 it may not matter due to the respective times for multiplication and divisions

3) Curve fitting routines in use

a) Boeing - least squares, floating point, $n \leqslant 10$, 100 input data points

b) Holloman - least squares, fixed point, $n \leqslant 5$, 21 input data points

c) Ramo-Wooldridge - mini-max, fixed point, $n \leqslant 15$, 582 input data points

All the above are in single precision.

The last session of the day was devoted to a discussion of the functions of the committee and proposals to be made to the Policy Committee of USE. A general approval of the program was expressed by all, and it was definitely felt that more such meetings would be fruitful. It was unanimously agreed that the Mathematics Committee should become a standing committee with a permanent chairman and with a permanent member assigned to the committee by each installation. Even though this permanent member might not necessarily attend each meeting himself, he would provide a contact at his installation for matters concerning the Mathematics Committee. These recommendations were presented to the Policy Committee. (See Appendix D).

A discussion of the function of the committee was initiated but tabled for the following morning session.

M. Green (Holloman) suggested that this committee, through USE, might jointly sponsor some University as a research project in an area of computation or numerical analysis for which either the time or talents of the member groups do not suffice.

Friday

The morning session was devoted to further discussion concerning the functions of this committee. These are summarized in the appended "Recommendations of the Mathematics Committee to the Policy Committee".

In the afternoon, Werner L. Frank began a discussion on mathematical routines by describing the development of the complete problem solvers being prepared at the Ramo-Wooldridge Corporation. (See Appendix C). Following this presentation, Joe Wegstein (NBS) presented two interesting problems which have been programmed at the Bureau of Standards. These were

1) Finding zeros of functions by iterating on x = F(x).

2) Finding extremum for functions by a "shot gun" method. One evaluates the function at a set of n points randomly distributed about a target point and selects the relative extrema for the function from these values. This extrema becomes the target point for the next set of points.

These informal discussions proved to be very fruitful in making known to the participants what is being done in the areas of research in new methods at the various installations.

The session adjourned at 3:00 P.M. to attend the final general session of USE. At this time the Policy Committee reported the disposition of several of the recommendations which were made by the Mathematics Committee and which are given in Appendix D. Although the Policy Committee felt that the meeting of the Mathematics Committee had been successful, nevertheless, sufficient time was not available for action on all the proposals. In particular, the proposals to give the committee a more permanent status were to be considered further. However, it was decided that a second meeting of the Mathematics Committee should be held with the next USE meeting in Washington D. C., on January 9 - 11, 1957. As recommended by the Mathematics Committee, the theme of the meeting will be "Spectral Analysis". For the meeting James Ward of Holloman was appointed chairman and Werner Frank was appointed secretary.

The Mathematics Committee was instructed to provide the Policy Committee with a detailed outline of the method described by Dr. Forsythe in the keynote address.

The chairman of the Mathematics Committee presented a report to the general session.

Werner L. Frank

Werner L. Frank

David M. Young, Jr.

David M. Young, Chairman

Appendix A

USE ORGANIZATION

AGENDA OF MEETINGS OF MATHEMATICS ~~COMMITTEE~~ COLLOQUIUM

Hollywood-Roosevelt Hotel, Los Angeles, California

October 4-5, 1956

Theme: Curve Fitting and Smoothing Techniques

Chairman: Dr. David M. Young, Jr., The Ramo-Wooldridge Corporation

Thursday, October 4, 1956

11:00 A.M. Keynote Address

"Generation and Use of Orthogonal Polynomials"

Dr. George E. Forsythe, University of California and The Ramo-Wooldridge Corporation

12:00 Noon Lunch

1:30 P.M. Session on Curve Fitting

A. "Curve Fitting by a Mini-Max Technique"

Dr. Phillip C. Curtis, University of California and The Ramo-Wooldridge Corporation

B. Informal Discussion

3:30 P.M. Discussion of the role of the Mathematics Committee

Friday, October 5, 1956

9:00 A.M. Session on Smoothing Techniques

A. Informal Discussion

12:00 Noon Lunch

1:30 P.M. Session on Mathematical Routines

A. "The Development of Mathematical Routines for a Computing Center Library"

Mr. Werner L. Frank, The Ramo-Wooldridge Corporation

B. Informal Discussion

Appendix B

Algorithm for computing best polynomial approximation of degree n to a continuous function f(x) on a finite set E.

Definition:

Let E be a finite set of points x_i, $x_o < x_1 < \cdots < x_n$. A function f(x) is said to oscillate on E if

$$\text{either} \quad f(x_i) = (-1)^i \left|f(x_i)\right| \quad i = 0, 1, \ldots n$$

$$\text{or} \quad f(x_i) = (-1)^{i+1} \left|f(x_i)\right| \quad i = 0, 1, \ldots n.$$

Let E be the set of N points ($N \geqslant n + 2$) at which the function f(x) has been recorded. We wish to compute the polynomial p(x) which minimizes the quantity

$$\max_E \left|f(x) - p(x)\right| .$$

The general step of the algorithm is as follows.

1) Let E_k be a subset of n + 2 points $x_i^{(k)}$ $i = 0, 1, \ldots n + 1$ of E which has been determined by the previous step of the algorithm. We assume $x_o^{(k)} < x_1^{(k)} < \cdots < x_{n+1}^{(k)}$.

2) Solve the n + 2 linear equations

$$f(x_i^{(k)}) - p_k\,(x_i^{(k)}) = (-1)^i \epsilon_k$$

for the coefficients of the n^{th} degree polynomial $p_k(x)$ and the error ϵ_k.

3) Compute $\delta_k = \max_E \left|f(x) - p_k(x)\right|$

4) If $\delta_k = \left|\epsilon_k\right|$, then $p_k(x)$ is the desired polynomial of best approximation.

5) If $\delta_k > \left|\epsilon_k\right|$, find a point $x^{(k)}$ of E such that $\delta_k = \left|f(x^k) - p_k\,(x^k)\right|$.

   Form E_{k+1} from E_k by replacing one point of E_k by x^k in such a way that $f(x) - p_k(x)$ oscillates on E_{k+1}.

This process is repeated until $\delta_k = \left|\epsilon_k\right|$. For E_o we may take any subset of E of n + 2 points. Since $\epsilon_o < \epsilon_1 < \cdots$ the process will converge in a finite number of steps (in the absence of round-off errors).

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5. Th. Motzkin, Approximations by curves of a unisolvent family, Bull. Amer. Math. Soc. 55 (1949) pp. 789-793.

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8. R. G. Selfridge, Approximations with least maximum error, Pac. J. of Math. 3 (1953) pp. 247-255.

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P. Curtis

Appendix C

The Development of Complete Mathematical Routines for a Computing Center Library

by

Werner L. Frank

I. Introduction

In order to solve the many types of problems presented to a Computing Center one usually prepares a library of basic subroutines facilitating computation common to most problems. These subroutines are then incorporated in specific production problems so that for changes in the input parameters many runs can be made for a given program.

There is, however, a group of every day bread and butter problems that are legitimate candidates for being coded as closed subroutines for some problems and yet in most instances are an end in themselves. These are usually the longer mathematical routines such as solution of a linear system of equations, roots of algebraic equations, fitting a curve to a set of data points, integration of an ordinary differential equation, etc.

Such problems can be programmed in very general forms so that they are valid for a multitude of cases. Coded with generality in mind, one then needs supply only the parameters or coefficients and the program will calculate the result. Hence a calling sequence used for the subroutine is not needed nor should it be required to compile or assemble such a program. We choose to call routines of this type complete problem solvers.

II. Purposes of the Complete Problem Solver

(a) To reduce time for the solution of standard problems by

1) reducing amount of coding necessary

2) eliminating need for general numerical analysis or problem formulation

(b) To reduce the possibility of making coding errors by minimizing coding by the user

(c) To be able to handle common variations of the basic technique by availability of options

(d) To monitor the computation sufficiently in order to provide checks on the input and intermediate computation.

In short, to provide for a complete and automatic performance of the computation requiring only the writing down of the input data according to a specified form.

In some problems a basic computation must necessarily be supplied by the programmer. That is, for example, in the Runga-Kutta-Gill integration procedure the evaluation of the derivative of the function at a point is incumbent upon the programmer and could hardly be anticipated by the writer of the subroutine. We, therefore require the concept of the Auxiliary Routine. This is a routine which computes a set of quantities intermittently as a function of arguments generated by the subroutine or carries out executive functions at the option of the programmer. In such cases the automaticity ascribed to the problem solver is no longer as complete.

III. Example

To illustrate these thoughts we consider the problem of solving the linear matrix equation $Ax = B$ by elimination. A number of associated problems can also be solved by such a routine by application of parts of the basic computation of the elimination process.

(a) $A\ x = b$ a system of n equations in n unknowns

(b) $A\ X = I$ inverting

(c) $A\ X = B$ m systems of n equations in n unknowns

(d) $\det\ (A - \alpha I)$ determinant or test of eigenvalues

(e) $(A - \alpha I)\ x = 0$ eigenvector associated with eigenvalue α

Wide flexibility is achieved by use of two auxiliaries. Auxiliary One provides successive rows of $[A,B]$ during the upper triangularization process while Auxiliary Two picks up the solution columns of X. In the former instance the matrix $[A,B]$ could be

1) stored in ES on magnetic drum or tape

2) on tape or cards

3) generated row by row.

Auxiliary Two can store the matrix in one of the internal storage units or punch out the results or both.

The most common problem is, of course, the one in which the matrix $[A,B]$ is punched on cards along with the side conditions, the dimensions of A and B. This information should be sufficient for the complete linear matrix equation solver to do any of the problems a, b, or c mentioned above. All that should be required is the reading in of the complete program and starting at a fixed location. Another alternative is to start at a fixed location in the way a service routine is activated assuming the complete program is stored on the drum with the rest of the library.

At The Ramo-Wooldridge Corporation effort has been directed to the programming of such problem solvers. The main contribution has been to minimize elapsed time between the formulation of the problem and its solution.

To set up the specifications for such a problem solver and for exploiting all its potential might well be a task relegated to the Mathematics Committee of USE.

Appendix D

RECOMMENDATIONS OF THE MATHEMATICS COMMITTEE TO THE POLICY COMMITTEE

1. The Mathematics Committee unanimously agreed that the ideas presented by the speakers in the discussion that followed will prove to be very useful to all members of USE. The numerical procedures that were outlined can be readily applied, and a great deal of time and effort can be saved. The Committee recommends that the method for curve fitting, as outlined by Dr. Forsythe, be studied and a USE program be prepared for the 1103A. The mini-max program, presented by Dr. Curtis, which is now in the repertoire of the Ramo-Wooldridge Corporation 1103 library, should be prepared for use on the 1103A.

2. In regard to the Mathematical Committee, unanimous approval by the participants is made of the following:

   a) The Committee be made permanent and meet concurrently with the regular USE organization.

   b) A chairman be selected.

   c) At least one permanent member be assigned to the committee by each installation.

3. Recommendations for the functions of the Mathematics Committee:

   a) To make recommendations to USE and member installations regarding mathematical routines which are desirable. This should include suggestions as to:

      (1) Method adopted.

      (2) Numerical procedure employed.

      (3) Testing procedure for checking the validity of the numerical results.

   b) To make recommendations for research and development of new methods.

   c) To report on development of new methods in the literature or new experiences in the representative installations.

   d) To conduct discussions concerning types of problems being currently solved in each installation with a view of exchanging experience in regards to method employed and results obtained.

   e) To set up programs for each USE meeting, for itself and also for a possible general presentation to the entire group. This should promote an interchange of ideas on the particular theme selected for that meeting through informal discussion.

4. The Committee would like to look into the development of standards for mathematical subroutines which would promote compatibility in their useage. For example, two distinct methods for doing a particular problem should be prepared in a way so that the calling sequence and that of presentation to both are equivalent.

5. The following topics are recommended for consideration for the next few meetings:

   (a) Ordinary Differential Equations.

   (b) Partial Differential Equations (Parabolic, Hyperbolic, Elliptic).

   (c) Monte Carlo Methods.

   (d) Spectral Analysis.

   (e) Eigenvalues of Non-Hermitian Matrices.

   (f) Solution of Non-linear Systems and Determination of Extremum.

   The Committee recommends the following order of interest in the topics for the next two meetings:

   (a) Spectral Analysis.

   (b) Ordinary Differential Equations.

6. The Committee recommends Dr. James Ward as temporary chairman for the following meeting, and Werner Frank as secretary.

7. Those present at these proceedings:

Jim Price	-	Boeing
Harry Shaw	-	A.P.L.
Joe Carlson	-	Lockheed
Richard Zemlin	-	Remington Rand
Jim Ward	-	Holloman
Harry Davis	-	White Sands (observer)
Marvin Green	-	Holloman
Werner Frank	-	Ramo-Wooldridge Corp.
David Young	-	Ramo-Wooldridge Corp.

Speakers: G. Forsythe, P. Curtis

Submitted by

David M. Young, Jr.

David M. Young, Jr.
Chairman, Mathematics Committee

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USE ORGANIZATION MEETING

October 4 and 5, 1956

Hollywood Roosevelt Hotel, Hollywood, California

Report of the Program Development Committee

The Program Development Committee met Thursday afternoon, October 4 and Friday morning, October 5. The following persons attended both meetings:

Don Cook (BA)
Tom Dewey (ML)
Richard Gunderson (RR, St. Paul)
Robert Perkins (RW)
Millard Perstein (RW)
Robert Rich (AP)
John Spencer (CE)
Robert Tantzen (HO)
Donn Combelic, Chairman (RW)

The following persons attended the Thursday meeting only:

Ed Dodge (ML)
Leo Kennedy (RR, St. Paul)
Richard Petonke (CE)
J. Wegstein, National Bureau of Standards

The following persons attended the Friday meeting only:

Roger Bate (CE)
Harry Davis (White Sands)
Robert Douthitt (RR, S.F.)
Bernard Dove (ML)

Agenda

The Policy Committee recommended the following items for the agenda of the Program Development Committee:

1. Progress Report on USE Compiler.
2. Proposed changes to USE Compiler.
3. Question Period on USE Compiler.
4. Presentation of Boeing Compiler.
5. Review of Programming and Coding commitments by the member organizations.

The committee tentatively added to this agenda the following items:

6. Use of peripheral equipment by the various installations.
7. Possible re-definition of standard USE machine.

8. Report on generalized print edit routine progress.
9. Future coding assingments.
10. Discussion of interpretive routine plans and requirements.

Items 7 and 9 were not considered by the committee. Item 7 appeared to overlap the assignment to the Machine Modification Committee.

The Boeing Compiler

Don Cook (BA) reported on the progress and on the major specifications of the Boeing Compiler. The coding of the Boeing Compiler is about 50% completed and the first check out version of the compiler will include the following features. 1) Ability to read symbolic instructions 2) ability to handle pseudo-codes 3) ability to assign storage automatically 4) a preliminary diagnostic routine 5) binary card output. Initially the input will be magnetic tape which has been transcribed from cards containing one instruction or line of coding per card. As indicated above, the initial output will be binary cards; Boeing expects to use paper tape to some extent in the future and eventually go into a fully magnetic tape operation. Some other features of the compiler presented were the following:

1. There will be no item number associated with each line of coding; rather the compiler will assign monotonically increasing integers to the instructions as they are processed so that the output lines of coding will have a number associated with them.

2. The use of pseudo-instructions is different from that of the USE Compiler: the operations part of a pseudo-code line of coding refers to the subroutine itself and this may be followed by several addresses. For example, for the sine-cosine subroutine, the u-address would specify the location of the argument, the v-address would specify the desired location of the result. The compiler will generate the appropriate calling sequence which in this case would be a TP for the argument and RJ to the subroutine followed then by a TP to transfer the result to the indicated location. In the case of subroutines requiring more arguments and control words, these would be specified in additional addresses. The least used parameters will be the last written address parts of this pseudo-instruction. Thus, if the programmer does not wish to specify some information, he may leave off the last of the several addresses regularly required. An example given had to do with a subroutine which would form the dot product of two vectors in floating point: the first address is the location of one vector, the next address the location of the other vector, the third address the location to which the product is to be sent, the next address how many elements, and the next address how much lost significance can be tolerated. In this case, the last address may be left off if it is not useable in any particular program.

3. For use with the compiler, Boeing has developed a specialized tape handling routine which essentially allows redistribution of information from magnetic tape into any of several useful forms. The compiler requires information in blocks of 240 words. A particular application

of this routine might be to segment the original input tape into a tape containing 240-word records with appropriate sentinel blocks.

4. The Boeing Compiler incorporates an input-output generator routine. The format of the output, including the heading line, the type of numbers, the layout of the printing, etc., is specified with a sequence of pseudo-codes. One of these pseudo-codes introduces a so-called sample line which can be processed by the input-output generator to produce the coding which will print out the line in the form indicated in the sample.

5. The system associated with the compiler includes a generalized diagnostic routine. This routine occupies a fixed location in core memory at all times. It can be entered by a programmer at any time, it is also entered as a result of executing an interpret instruction, when a program interrupt takes place, when an alarm exit is encountered in a subroutine. The routine uses the Flexowriter for brief output which gives information about the type of error, the location in the main program, and any other information appropriate to the case in point. The complete generalized diagnostic routine occupies, in addition to 125 words in the core memory, about 25 blockettes on magnetic tape. That part of the diagnostic routine entered via the alarm exit from subroutines finds certain information in the Q-register and the accumulator at the time of the alarm exit to the diagnostic routine. The Q-register is used to contain not more than 6 flexocode characters which are immediately printed out on the Flexowriter identifying the type of alarm. The accumulator OP code contains a number specifying how many control words are to be printed by the diagnostic routine and the v-address part contains a comment number which references some cells containing Flexowriter information which when printed give a fuller explanation of the error. The sign bit in the accumulator is used to specify whether or not the stop is recoverable. If the stop is recoverable, the sign bit is made a 1 and after the appropriate information has been printed on the Flexowriter the program may be continued by punching the start button. If the stop is not recoverable, the master diagnostic routine in core memory dumps all of core memory on magnetic tape and then reads in from tape part 2 of the diagnostic routine which takes over from there, its course of action depending on the type of error detected.

Don Cook (BA) indicated that Boeing may be able to get a writeup of the Boeing Compiler circulated to all USE members in the near future. It was agreed that this would be a most valuable document. Some comments about certain features above were as follows. Rich (AP) suggested printing all numbers in both octal and floating point on any static memory dump routine. The specifications of the format of the output generator were discussed briefly, particularly with reference to using some kind of a matrix scheme for describing the layout of an entire page. The comment was made that this was a relatively difficult and hard to use method compared to the method of using successive pseudo-codes to describe the various lines of the page layout.

Verfying

The RR representative had indicated that a Unitape Verifier will not be available for perhaps a year. As a consequence, the subject of verification without a verifier was discussed in the meeting. Boeing is emphasizing at the present time the punching of cards followed by card-to-tape conversion with magnetic tape then becoming the primary input to their compiler. They expect to punch only one deck of cards, then run that through the card-to-tape converter, list this tape on the high-speed printer, and proof read that print-out visually by comparing with the original manuscript. This procedure is admittedly only provisional mainly because Boeing has no experience with the Unitapes and no card verifying punch. They expect to paste appropriate tabs on the keys of the 026 card punch to conform with the output of the high-speed printer. Presumably this would simplify the task of the typist in producing an output which will conform, or rather which will produce conformity, between the high-speed printer output and the original manuscript.

DELETE

~~Dewey (ML) said that at Lockheed they expect to produce two Unityped tapes and use the machine to check one against the other and have the machine decide which tape is correct. Clearly this presupposes that one of the tapes is in fact completely correct, which may occur so infrequently as to make this system impractical.~~

Spencer (CE) has had some experience with the Uniservo tape units on the Army Map Service UNIVAC. When there are only a few discrepancies between the two tapes which are prepared at this UNIVAC installation, they can be compared by the machine and the programmer can select and inform the computer which tape is correct for each discrepancy. The machine then produces a third tape with the correct version of those entries which disagree.

At the request of the Chairman, Joe Wegstein of the National Bureau of Standards talked briefly of his tape comparison experience on the NORC computer. On that machine the original input is cards and during subsequent running and check-out of a given problem the updated programs are kept on magnetic tape. He uses two tape records alternating from one tape to the other with the new updated version. If the most recent version is destroyed, the previous one is still available and the written record of the changes can be incorporated again to update the program. At the SEAC installation two paper teletype tapes are prepared and compared visually before the correct one is inscribed to magnetic wire. Wegstein also pointed out that if two tapes are prepared with the intent of comparing them, to produce a third correct tape, it is helpful if the typewriter operators are experienced and are able to use the touch system in tape preparation--in addition it is important that the typescript produced during typing compare directly with the manuscript from which the typing is being done.

Rich (AP) is going to have a card system in operation and expects, at least at first, to emphasize card input on their 1103A. He made the point that unless the overall ease and excellence of Unityper operation is far better than that of cards, it did not appear to them that they should go over to direct magnetic tape input using Unitypers.

Combelic (RW) pointed out that the Univac people had on some occasions prepared three Unityper tapes and used the machine to compare them, resolving discrepancies on a two out of three basis. They found that in no case did the two out of three choice lead to an incorrect tape. Of course the UNIVAC was producing a fourth tape which was correct on the two out of three basis. This suggestion of a method of verfying input magnetic tapes was received in a manner that prompted Joe Wegstein of National Bureau of Standards to describe a project he has been working on for the past few months.

A paraphrase of his remarks is given here. Many of the programmers at NBS have an opportunity to program and check out routines on a great variety of machines: for example, 704, UNIVAC, NORC, SEAC, 701, 1103A, etc. On the basis of his experience at these various installations, Wegstein reached the conclusion that some installations may not be using their peripheral equipment in the most efficient way considering the type of problems, the main computer, and the nature of the input-output equipment available. He is working on the design of a mathematical model of an operations system for a digital computer. The objective is to obtain a figure, or figures, of merit by which the efficiency of an operational system including information about all the inout equipment, etc., could be measured in a scientific manner. The simplest model would be some kind of a weighted sum, where the initial determinations of the weighting coefficients would be made on an empirical basis. This means that some initial guess at the values of these weighting coefficients and the form of the function would be made and then the constants for a particular installation (for example, card reading speed, tape speed) would be put into the function. The figure of merit would then be evaluated for that installation. This would be repeated for other installations and a subjective evaluation of their operation would be compared to the figures of merit obtained by this mathematical model. On this basis it is hoped that some adjustment of the weighting coefficients could be made so as to produce a function which would yield useable figures of merit for other proposed installations, or perhaps show how an established installation might improve its operation. If Wegstein can come up with a mathematical model of an operational system of a digital computer which can yield fairly good results, it will be a great step forward in deciding questions of the type just discussed here, namely verifying.

The USE Compiler

Bob Perkins (RW) gave an oral report on the progress in planning, coding, and checking out of the USE Compiler. A copy of this report is attached as the last page of this report. In summary, Perkins reported that the compiler is more than 90% flow charted, about 50% coded and 40% checked out. He expects that the first check-out version of the compiler will be ready for check out on the Lockheed 1103A about October 22. This version of the compiler will be able to translate a simple program from beginning to end. As the bugs are removed from this version, new sections will be inserted as their coding and preliminary check out is completed. Perkins reported that 7 people are now working nearly full-time at RW on the USE Compiler. He was unable to give an exact date when the USE Compiler as now specified would be completed. However, it appears that a version which will handle most cases will be ready approximately December 1.

Perkins distributed the "USE Compiler Programming Manual I" to the members present. Additional copies may be obtained through the Executive Secretary of USE. Perkins pointed out that the Manual was not as complete as he would like to have had it. There are no examples in the writeup and some features could probably be explained in more detail. RW expects to produce the 2nd edition in time for the next USE meeting. It will include examples, perhaps some appendices giving detailed explanations where required. Also those parts of the present report which may be found unclear will be rewritten or expanded as required. It is hoped that considerable feedback on this Programming Manual will be obtained from the members of USE so that the next manual can be improved and made more useable.

RW has assumed the responsibility of developing a Compiler Reference Manual which will contain a description of how the compiler works, all the pertinent flow charts and annotated coding and explanations of the overall plan. This Manual will then serve as a reference for people who have the responsibility at their installation for keeping the compiler working, making changes as required, etc. This represents a major undertaking and in anticipation of this, all flow charts associated with the compiler have been kept up-to-date during the coding of the programs.

Changes in the USE Compiler

Certain changes had been suggested in the USE Compiler by Roger Bate (CE).

1. "Permit subroutines to refer to other subroutines".

   Perkins indicated that this change had been communicated by Bate about 6 weeks before the USE Meeting and that the facility requested has been included in the USE Compiler.

2. "Permit use of L(C) in subroutines or establish a constant pool of often-used constants".

   Perkins reported that it would be very difficult to permit the use of L(C) in subroutines. Further, it had been previously agreed by the USE Organization that there would not be a constant pool.

3. "Subroutine temporary pool of required length which can be shared by all subroutines in a compiled routine".

   Perkins pointed out that the first part of the compiled region was a temporary storage pool of sufficient length to handle any subroutine which had been incorporated by the USE Compiler. The location of the first cell of the temporary pool corresponds to the first cell of the compiled region, and is controllable. This location may be specified by use of the COMPAT control word.

4. "Names of subroutines to be two-character installation code and four alphanumeric characters instead of USE xxx".

   Perkins reported that the USE designation had been abandoned shortly after the previous report was written and that the suggested two-character installation code followed by four alphanumeric characters system was being used in the USE Compiler in its present version.

The above four changes were suggested by Bate--all except no. 2 have been incorporated in the USE Compiler.

The first version of the USE Compiler will assume a standard high-speed printer and a standard Unityper. For installations which will have the modified high-speed printer and the modified Unityper the compiler can be changed without too much difficulty. Also the present version is designated to operate with 4,096 registers of core memory. A simple change will allow the compiler to take advantage of either 8,192 or 12,288 core memory registers. The compiled region unless otherwise located by the programmer will occupy the high address end of the core memory storage--consequently, the ability of the compiler to be changed as just indicated may be important.

Further discussion of the USE Compiler was deferred until the following day so that the committee members and others would have a chance to read Programming Manual I.

Coding Responsibilities of Member Organizations

A check-back on coding assignments for common function subroutines and elementary input-output subroutines was made at this time. The common function assignments as previously agreed upon were confirmed as follows:

1. Exponential Stated and Floating Point - Ramo-Wooldridge
2. Logarithm Stated and Floating Point - Remington Rand
3. Square Root Stated and Floating Point - Remington Rand
4. Sine-Cosine Stated Point - Remington Rand
5. Sine-Cosine Floating Point - Ramo-Wooldridge
6. Arcsine-Arcosine Stated and Floating Point - Remington Rand
7. Arctangent Stated and Floating Point - Ramo-Wooldridge

The elementary input-output routines assignments and progress are as follows:

1. Floating-Point Data Tape Input - Lockheed
2. Octal Data Tape Input - Lockheed
3. Stated-Point Data Tape Output Off-line. Boeing has completed this routine but it will have to be changed in some respects. Boeing will carry out this work and circulate the information. No assignment of the online version of this routine has been made.
4. Floating-Point Data Tape Output - Remington Rand. The off-line version of this routine has been completed; Remington Rand is working on the on-line version.
5. Variable Field Card Input Stated Point, Floating Point, and Octal. Lockheed has assumed the responsibility for this routine and as soon as it is completed, they will circulate the information.

6. Jump Trace Routine. Lockheed is working on this routine and will present a report on it at the next USE Meeting.

Rich (AP) is working on a card input routine wherein the first five columns comprise a storage address, this is then followed by 12 six-digit number fields.

Question Period on USE Compiler

On Friday morning the first item was a question and answer period on the USE Compiler. Rich (AP) had several questions on the writeup which were answered by Perkins. Some of the questions arose merely because of minor ambiguities in the description of certain features of the compiler. Perkins made notes on these questions and in the next version of the Programming Manual the writeup will be changed to obviate most of the questions in the future. The inclusion of examples in the Programming Manual should enhance its value and also answer a great many questions similar to those asked during this period of the committee meeting.

Generalized Print Edit Routine

Zonars (WF) handed out a three page report on specifications for a generalized print edit routine which had been prepared at his installation since the last USE Meeting. Copies of this report may be obtained from the Executive Secretary of USE. Study of the report showed that Zonars and his people had given a great deal of thought to the problem and had come up with a workable system. However, it did appear that there had been some misunderstanding about the type of generalized print edit routine which the other members of USE had in mind at the time the project was assigned to Wright Field and the Corps of Engineers. Zonars reported that he and his people had been unable to get together with anyone from the Corps of Engineers since the last meeting; so that the original plan of planned cooperation was not possible. The chairman of the committee and a couple of other members tendered their apologies to Zonars because of this misunderstanding and it was agreed that the USE Organization wanted to take a bigger step toward a generalized edit routine than that indicated in the specifications submitted by Wright Field.

Roger Bate (CE) reported briefly on a scheme he had thought about for specifying output format in a general way. His scheme essentially consists of an interpretive routine which could interpret 8 different instructions which could be used to control output format. Talmadge (ML) suggested that perhaps the output edit routine should be of the generator type, for example, "sample lines" to specify the format. Considerable discussion of these and other schemes followed without much agreement.

It was finally agreed that representatives of Wright Field, Corp of Engineers, and the Applied Physics Laboratory would meet at the Corp of Engineers in Washington D.C. about November 1st to try to reach agreement on specifications of the generalized print output edit routine. It was further agreed that Roger Bate would act as the Eastern representative at a meeting to be held in Palo Alto, California, about the middle of November. This meeting would be attended by Bate of the Corp of Engineers and representatives of Ramo-Wooldridge, Lockheed Missiles, and Boeing. At this time Bate would present the tentative specifications agreed upon at the Washington meeting. The objective of the Palo Alto meeting is to come up with a mutually agreed upon set of specifications for an output editing routine.

TRANSUSE Conversion - Holloman

Tantzen (HO) reported that progress has been considerable. They expect to complete the checkout of the TRANSUSE conversion program by the end of October using the Lockheed Computer in Palo Alto. Certain changes have been made in the TRANSUSE language so that it can be handled by the USE Compiler. Tantzen distributed copies of a Programming Manual for people wishing to code in the TRANSUSE system.

Tantzen asked informally that the organizations report on their plans for using the peripheral equipment with their 1103A. Each member briefly reported on how he planned to use the equipment immediately after his computer arrived and also how he thought this use would develop in the future. One thing seemed to be pretty generally agreed upon, namely, that even though some organizations plan to use paper tape in the beginning, its use will gradually decrease in their installations. Boeing plans to emphasize card equipment rather heavily at first but eventually expects to go over to almost a full magnetic tape operation. Other installations indicated that they expected to use paper tape temporarily but gradually this will be replaced by card input and output and then later by magnetic tape input and output.

The formal meeting of the Program Development Committee adjourned after some further discussions and with the agreement that an extra session would take place after the general meeting approximately 4:30 that same afternoon.

Discussions at Extra Session

The discussions at this meeting were informal. Some interest was expressed in an interpretive routine using double precision floating point operation. At the present time the exact form of a double precision floating point number has not been decided by the USE Organization. The so-called double characteristic system which allows a 54-bit mantissa and the single characteristic system with a 62-bit mantissa are the two possibilities. An experimental approach to find out which of these is the best, in some sense, is indicated and Remington Rand said that they have done some research in this matter and will report their results at some future time. There was brief discussion of matrix abstraction routines. Ed Dodge (ML) indicated that Lockheed may produce a matrix abstraction for use on the 1103A. Remington Rand reported that they are flow charting a generalized tape handling routine which allows for automatic recovery from any tape error. Also, they reported that the Unimatic Algebraic Coding System is approximately 90% flow charted and 10% coded.

It appeared from the tone of the discussion that it would not be possible to make any coding assignments about matrix abstractions or interpretive routines at this time. It was agreed that any organization that produced such a routine would make it available to other members after it had been checked out at the originating installation. There was interest in discussing other matters, but time did not permit.

The Program Development Committee will meet again at the next USE Meeting in Washington D.C. with the Applied Physics Laboratory and Remington Rand acting as hosts, January 9, 10, and 11, 1957.

Respectfully submitted,

Donn Combelic

Donn Combelic, Chairman
Program Development Committee

USE COMPILER PROGRESS REPORT

October 4, 1956

This report covers progress on the USE Compiler since the USE Meeting in Minneapolis on July 12 and 13, 1956. During this period the following persons at R-W have worked on the compiler: Sue Knapp and Phyllis Van Liew, full-time, and Millard Perstein and Bob Perkins, about three-fourths time.

Progress can be reported in four areas: Specifications, Flow Charts, coding and check out, Programming Manual.

1. The suggestion of Roger Bate (CE) and others that cross referencing among subroutines be permitted has been investigated. Although not included in the original specifications, this certainly seems desirable. The difficulties involved have been overcome and this feature is now included in the compiler. Normally the compiler will insure that all necessary subsidiary subroutines are in the compiled region. The programmer may override this, however, and specify that a copy of the subsidiary subroutine at any specified location is to be used.

2. Detailed flow charts for about 90% of the compiler have been completed and kept up-to-date. In addition, many pages of lists, charts and notes describing in detail the operation of various parts of the compiler have been written up.

3. About 2200 lines of coding have been written or about half of the 4000 to 5000 which will be required. Of these about 1600 have been checked out on the 1103. Some of the remaining 600 are currently being checked out on the 1103. The rest are tape routines which require the 1103A for check out. The first parts of the compiler to be coded have been selected so that they may be tied together to form a package for check out. It is expected that such a check out package will be ready for check out on the Lockheed 1103A in Palo Alto sometime during the last half of October. As the remaining parts of the compiler are coded and checked out they will be added.

4. The first version of a Programming Manual for the USE Compiler has been completed. It provides the experienced programmer with the information ordinarily needed to prepare a problem using the compiler. The Programming Manual will be supplemented, at a later date, with illustrative examples and with a Reference Manual which explains the operation of the compiler in detail.

Report prepared by: R. Perkins, RW

Talmadge

TENTATIVE AGENDA

EIGHTH USE MEETING

9-11 January 1957

I PLACE: Shoreham Hotel, Washington, D. C.

HOST INSTALLATION: Applied Physics Laboratory of
The Johns Hopkins University

II TIME SCHEDULE

<u>Wednesday, 9 January 1957</u>

A. Policy Committee (Closed) 8:30 a.m.

B. General Session, 11:00 a.m.

C. Lunch, 12:00 Noon

D. Colloquium Talk, 1:00 p.m.

E. Committee Meetings (Open), 2:30 p.m.

F. Colloquium (Restricted), 2:30 p.m.

<u>Thursday, 10 January 1957</u>

A. Working Committee Meetings, 9:00 a.m.

B. Colloquium, 9:00 a.m.

C. Lunch, 12:00 Noon

D. Committee Meetings, 1:30 p.m.

E. Colloquium, 1:30 p.m.

<u>Friday, 11 January 1957</u>

A. Open, 9:00 a.m.

B. Policy Committee Meeting (Closed), 9:00 a.m.

C. Lunch, 12:00 Noon

D. General Session, 1:30 p.m.

III ITEMS FOR COMMITTEE CONSIDERATION

A. Administrative

P 1. Nominations for Chairman and Executive Secretary for fiscal year 1957. Rich Announcement.

P 2. Approval of minutes of previous meeting.

P 3. Action on committee reports of previous meeting.

P 4. Whither bound the Colloquia?

P 5. Date and place of next meeting.

P 6. Computing time available to USE as an organization.

P 7. Action on committee recommendations, if any, present meeting.

P 8. Review of basic policies of USE; particularly with respect to:

a. Mail voting
b. Salesmen

P 9. what to do with old chairman.
P 10. Executive Secretary.

B. Non-Administrative

1. Status of Programming Manual - General Session (Leo)

~~a. Present version~~
~~b. Should a committee be formed to draft final version?~~

2. Reconsideration of minimum USE machine.

3. Tape handling in the absence of a verifier.

4. Availability of Uniservo Rings to prevent accidental writing.

PDC 5. Committments for service routines.

PDC 6. High speed printer generalized edit routine.

PDC 7. Report on compiler. (RW)

8. Status of USE machine modification requests. G.S. (Ted)

PDC 9. Report on TRANSUSE. (HO).

PDC 10. Catatoging of USE programs.
11. Machine modifications
PDC 12. MAFIA discussion. Discussion from floor
13. Verifier - letter
14

REPORT OF THE MATHEMATICAL COMMITTEE FOR THE WASHINGTON MEETING

January 9-11, 1957

The theme of this meeting was Spectral Analysis. There were four colloquia and a business meeting. The first colloquium was the keynote address to the entire USE assembly. Attendance at the other meetings ranged from 12 to 22 people. The speakers were:

Harry Press, NACA Langley Field - Keynote speaker

L. M. Spetner, Applied Physics Laboratory

Joseph Carlson, Lockheed Missiles

Werner Frank, Ramo-Wooldridge

Each of these made very excellent presentations. Few of the committee members knew much of the topic before they came but feel they have learned a great deal from four such experts. Details of the talks will be given in the minutes of the Committee.

The Mathematical Committee wishes the Policy Committee to take action on the following items:

1. To select a chairman for the Mathematical Committee. The Mathematical Committee nominates

✓ James A. Ward, Holloman

David Young, Ramo-Wooldridge

Werner L. Frank, Ramo-Wooldridge

2. To select a theme for the next mathematical colloquia. The Mathematical Committee recommends

✓ a. Ordinary differential equations

b. Reports on status of the programs of previous themes: curve fitting and frequency analysis

No keynote speech 3. To rule on the desirability of the keynote speaker being furnished by the Mathematical Committee at the next meeting, or at each meeting.

4. To rule on the payment of an honorarium to invited speak~~ers.~~ No If such is desirable, should it be paid by Remington Rand on by the Host installation?

5. To act on the following recommendations:

The Mathematical Committee recommends:

a. An 1103A program ~~from~~ for spectral analysis be written to conform with the specification given below.

b. The task of writing this be assigned to APL (APL has announced willingness to do so.)

James A Ward

James A. Ward - Temporary Chairman

Werner L. Frank - Secretary

SPECIFICATIONS FOR PROGRAM FOR AUTOCORRELATION AND SPECTRAL ANALYSIS

1. The program should follow the Tukey method.
2. The program should be for the minimum 1103A and for core storage.
3. The input and output routines should not be included. The data should be assumed to be in a specified place and the answers be left in a specified place.
4. The data should be limited to 4 decimal digits and all computations should be in fixed point.
5. The number of lags should be left as a parameter.
6. The data storage should follow the lag storage space so that the data storage should be longer for a small number of lags.
7. The output should include the mean, the autocorrelation result, and the spectrum density.
8. The coding should be sectional to permit easy modification and insertion by the using installations.

- 2 -

Talmadge

USE Organization

Special Report

5 January 1957

Basic UNIVAC Tape Servicing Routines

The following report was submitted to the Executive Secretary by Mr. Richard H. Petonke, (CE), in correspondence dated 17 December 1956. This information was requested of Mr. Petonke at the Seventh Meeting of USE in Los Angeles, 4, 5 October 1956. Similar information was reported by Mr. Jules Mersel (RR) at the February 16, 17 meeting of USE, and can be found on pages 3, 4 of the Program Development Committee report for that meeting.

"This report intends to deal with only those routines whose purposes are strictly for servicing magnetic tapes, not for servicing data or written programs. A file maintenance system will have to be developed for servicing data, and a diagnostic scheme for servicing programs.

Basic tape servicing routines can be placed into three categories:

1. Comparators
2. Correctors
3. Locators

1. Comparators

This type of routine compares two or more copies of information listing all discrepancies with their locations either on magnetic tape or on Supervisory Control typewriter. A probable extension would be to produce a correct output tape from the discrepant input tapes.

2. Correctors

The basic operation employed in this type of routine is to copy a tape or a portion of a tape to another tape making the necessary changes to the information when it is placed in the memory. Various options can be added. For example, copy without corrections, skip through a tape forward or backward, rewind tapes, and change the write density on tape.

The supervisory operations can be controlled manually for "spur of the moment" changes, or by auxiliary input prepared in advance.

An example of an automatic corrector routine is AC4 (Autocorrector, Model 4). Both the new word and the old word are entered on the correction tape along with the block and word location. These correction items must be in ascending sequence by block number. Before a correction is made, the original word is compared with the supposed original word from the correction tape as an added check for a programming error.

Another type of corrector is a rearrangement routine. This can alter the alignment of words within an item, items within blocks, or can expand item sizes, introduce constants within items, etc. This same idea has been expanded to two tapes by the Army Map Service in a routine called the 2-tape Rearrange. Pertinent information stored on two tapes concerning an individual item can be merged in a variety of ways producing one complete item on one tape. It also can be adapted as a straight two-way merge.

3. Locators

The principal purpose here is to locate a particular program, block, word, or partial word. Locate might mean to position the reading head in the space preceding a desired program or a particular block. It can also mean to print on the supervisory control typewriter the exact location or locations of a unique word or partial word. If no such word is found there might be a typeout to that effect.

A locator routine is a standard part of most library tapes, being recorded in the first blocks. Upon initial reading the first block and transferring control to the routine, the locator finds the desired program and reads it into the computer memory, transferring control to the entrance line of that desired routine.

There are several omniferous routines in existence which have combined features from all three categories. Two of them are Mark VIII and Omnibus. An additional feature of Omnibus is the ability to sample a tape, ie. it will type out or write on tape any desired word of each successive block of a tape.

These particular types of routines are in frequent use at UNIVAC installations and they will undoubtedly greatly influence our own decisions about tape servicing routines."

Leo B. Kennedy

Leo B. Kennedy,
Executive Secretary, USE

Talmadge

Mr. Wayne M. Aamoth
Remington Rand Univac
Univac Park
St. Paul 16, Minnesota

Dear Mr. Aamoth:

We should like to impress upon you the severe handicap which is being inflicted on design of adequate tape input systems by the absence of tape verifying equipment. In several contemplated systems, the speed advantages of tape over cards are being almost completely negated by non-existence of off-line verification equipment.

It is our understanding that this equipment will be available after July, 1957. We earnestly hope that this schedule will not slip and further hope that some accelleration may be possible. Although we understand that Univac users have lived with this equipment deficiency for years, we feel that certain differences in design and operating techniques intensify the handicap inflicted on 1103A users.

It is further requested that a manual describing the operating specifications for this equipment be prepared and be made available prior to the availability date of the equipment.

Very truly yours,

Wayne M. Aamoth
Remington Rand Univac
Univac Park
St. Paul 16, Minnesota

Dear Mr. Aamoth:

The USE organization has been informed that the engineering required to incorporate locking rings on the present 1103A Uniservos has been initiated. As members of this organization we urgently request that the finished product incorporate the following behaviour: if a Uniservo is referenced by a Write EF instruction when the locking ring is in position, the computer will wait for further action before executing any subsequent commands. In effect, this is identical to the behaviour previously requested when referencing a tape unit in the "not ready" status.

It is further requested that suitable indication, preferably lights on the Uniservo, be provided for this occurrence, and indeed for any reference of a Servo in the "not ready" status during execution of a program.

Very truly yours,

Mr. Wayne M. Aamoth
Remington Rand Univac
Univac Park
St. Paul 16, Minnesota

Dear Mr. Aamoth:

At the USE meeting of 9-11 January 1957 in Washington, D. C. a new committee, called Installation Operations, met for the first time. One of the functions of this committee was to discuss possible modifications of the 1103A, particularly with respect to indication aids for the machine operator.

The discussion showed that the following items would be desirable as operating features:

1) A light on the Uniservo indicating the WRITE mode of operation.

2) Two rows of five lights on each Uniservo to indicate the logical assignment of the Uniservo.

3) A bank of lights on the Uniservo to indicate the status of the Uniservo under any mode of operation.

4) A bell under control of a switch on the operator's console to indicate when the computer stops.

Therefore we, as members of USE, request that you investigate the possibility of incoporating the above features as integral parts of the 1103A computer.

Very truly yours,

USE MEETING ATTENDANCE
JANUARY 9,10,11
WASHINGTON, D.C.

NAME	COMPANY
Two Representatives	Boeing
Dick Talmadge	Lockheed Missile Systems Division
Tom Dewey	" " " "
Joe Carlson	" " " "
B. C. Dove	" " " "
3 - 7 Representatives	Johns Hopkins--Operations Research
Harry Petersen	WADC
Demertius Zonars	"
Leonard Fall	"
F. W. Bauer	"
Robert G. Tantzen	Holloman Air Force Base
Marvin C. Green	" " " "
Dr. J. A. Ward	" " " "
Donald Gantner	Ramo-Wooldridge
Robert Perkins	" "
Donn Combelic	" "
Werner Frank	" "
Jack Reynolds	Lockheed
C. Zimmer	Remington Rand
T. W. Wilder	" "
I. Voltin	" "
E. Joseph	" "
E. Zemlin	" "
D. Squire	" "
L. Kennedy	" "
R. Gunderson	" "
E. Haight	" "
G. Pickering	" "
B. Mittman	" "
R. A. Terry	" "
T. W. Helweg	" "
One Representative	Union Carbide Nuclear Company
George J. Moshos	National Advisory Committee for A.
Miss Alice Graham	White Sands Proving Ground
Mrs. Gray Pyle	" " " "
Warren B. Koch	Glenn L. Martin Company
Five Representatives	Corps of Engineers--Dept. of Army
Four Representatives	Frankford Arsenal
Richard Todd	Eglin Air Force Base
Dr. D. A. Flanders	Argonne National Laboratory
C. Barkley Fritz	Westinghouse Air Arm Division
Don Holmes	California Texas Oil Company
Dave Feign	Cornell Aeronautical Lab.
Carl Tross	American Bosch Arma Corp.

USE MEETING ATTENDANCE
(cont'd)

NAME	COMPANY
Mr. Kelly	Union Carbide Company
Aaron Finerman	Republic Aviation Corporation
Glenn Shook	National Security Agency
Dorothy Bates	" " "
Dorothy Blum	" " "
Bob Gildea	RCA
Ruth McNaughton	"

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Talmadge

MINUTES OF THE MEETING OF USE

Washington, D. C.

9-11 January 1957

Wednesday, 9 January 1957

I. Policy Committee Meeting, morning session.

1. The meeting was called to order at 8:45 a.m. with the following members present:

R. B. Talmadge (ML), Chairman
R. P. Rich (AP)
D. I. Cook (BA)
B. C. Dove (ML)
E. Joseph (RR)
J. W. H. Spencer (CE)
D. W. Gantner (RW)
M. Green (HO)
L. Fall (WF)
L. B. Kennedy (RR), Executive Secretary

2. Agenda preparation was the first item of business. The result was as follows:

a. Policy Committee

(1) Nominations for chairman and Executive Secretary for fiscal year 1957.
(2) Approval of minutes of previous meeting.
(3) Action on committee reports of previous meeting.
(4) Whither bound the colloquia?
(5) Date and place of next meeting.
(6) Computing time available to USE as an organization.
(7) Action on committee recommendations, present meeting.
(8) Review of basic policies of USE, particularly with respect to
   a. Mail voting
   b. Salesmen
(9) Status of an ex-chairman.
(10) Clarification of duties of Executive Secretary.
(11) Progress of programming manual.

b. Program Development Committee
Chairman: D. Combelic (RW).

(1) Commitments for service routines.
(2) Catalogue of USE programs.
(3) High speed printer generalized edit routine.
(4) Report on Compiler, (RW).
(5) Report on Transuse, (HO).
(6) Report on MAFIA, (ML).

c. Installations Operations Committee
Chairman: D. Cook (BA).

(1) Reconsideration of minimum USE Machine.
(2) Tape handling in the absence of a verifier.
(3) Availability of Uniservo locking rings.
(4) Status of USE modification requests.
(5) Machine modifications:
  a. 3-way tape switch
  b. Status lights on Uniservos
  c. Programmed interrupt
(6) Card to tape converter
(7) Verifier.

Again no attempt was made to set an agenda for this colloquium. However, in view of the recommendations made at the previous meeting, and the evident need for clarification of status, it was decided to hold a special session of the policy committee at 1:00 p.m. to consider item A(4).

3. The minutes of the previous meeting were unanimously approved with the following corrections:

a. In the report of the ad hoc committee on programming topics, the sentence on page 2, item 4, "Dick Petonke....paper tape." is in error and is deleted.

b. The word "colloquium" should be substituted for the word "Committee" throughout the Proceedings of the Mathematics Committee.

c. In the report of the Program Development Committee, page 4, the paragraph starting "Dewey (ML) said...." is in error and is deleted in its entirety.

4. From a discussion of the duties of the Executive Secretary it was evident that his presence at Policy Committee meetings was highly desirable. Therefore it was moved, seconded, and unanimously carried: "The Executive Secretary of the USE organization shall sit with the Policy Committee as a non-voting member."

Gantner (RW) felt that the word "Executive" in the title implied authority and responsibility not, in fact, held by the Secretary and moved: "The title of Executive Secretary be amended to read Secretary." After some discussion the motion was seconded, but was defeated upon a vote.

5. Similarly, the following motion was seconded and carried unanimously: "An outgoing chairman of the USE Organization is invited to serve as a non-voting member of the Policy Committee for a period of one year."

6. It was generally agreed that the Executive Secretary must be from Remington Rand in order to carry out his duties effectively. Joseph (RR) nominated Kennedy (RR) for Executive Secretary for the fiscal year 1957. No other nominations were made, and Kennedy was unanimously elected.

Nominations for chairman were as follows:
Spencer (CE) nominated Rich (AP), second by Clark (OR)
Green (HO) nominated Gantner (RW), second by Dove (ML)

The result of a closed ballot favored Rich. Spencer (CE) moved that the vote be made unanimous for Rich. The motion was seconded and carried unanimously.

7. The session adjourned at 11:05 a.m.

II. Policy Committee, Special Session, 1 p.m.

1. The somewhat lengthy discussion of the status of the mathematics colloquia is perhaps best summarized by the motion submitted by Gantner (RW) and unanimously carried. It reads as follows:

a. The mathematics colloquia shall be made a regular standing committee of the USE organization with a chairman appointed by the policy committee.

b. The general subject for each meeting shall be chosen by the policy committee, usually from recommendations submitted by the mathematics committee.

c. Although for some meetings the agenda of the mathematics committee may include some mathematical presentations of a general nature, the committee shall avoid becoming a "small mathematical society", but rather shall adopt as its principal objectives:

(1) The exchange of working codes for mathematical subroutines;
(2) The description of computational experiences derived from using existing mathematical subroutines;
(3) The discussion of promising mathematical methods with the idea of developing mathematical subroutines using these methods;
(4) The preparation of general specifications for proposed mathematical subroutines. In each case a member organization shall be designated to prepare more detailed specifications, and to develop a working machine program.

2. The session was adjourned at 2:20 p.m.

<u>Friday, 11 January 1957</u>

I. Policy Committee, 9 a.m.

1. The committee met at 9:15 a.m.

2. After some discussion involving the length of time between meeting, the committee voted unanimously to accept the suggestion of Fall (WF) that the next USE

meeting be held at Dayton, Ohio on 17-19 April 1957.

(NOTE: By a mail vote of the policy committee members, the dates were changed to 24-26 April 1957 in order to avoid conflict with the Easter Holidays).

3. The decision as to time and place of the next meeting drew some interesting comment on the organization of the meetings. Spencer (CE) suggested that the meetings be reduced to two (2) days, with the policy committee meeting the night prior to the first day. The point being that some organizations would find it difficult to send as many people to a three (3) day meeting as to a two (2) day meeting.

Gantner (RW) proposed that the meetings remain three (3) days long, but that only the policy committee meet on the first day, with the committee meetings and general sessions not starting until the second day. The advantages of such an arrangement were perceived immediately, and the committee voted unanimously to try the procedure at the next meeting.

4. The chairman next explained the basis on which Remington Rand had donated forty (40) hours of machine time to USE as an organization, to be administered, in the absence of a directive from the policy committee, by the chairman. He pointed out that the time must be taken on either the Lockheed or Boeing Machines on an extra shift basis (thus not interfering with the regularly scheduled shift); that of the original forty (40) hours, twenty-one (21) had been used by Holloman for checkout of TRANSUSE, and ten (10) by Ramo-Wooldridge for the Compiler; and that apologies were due for the somewhat haphazard administration of the time up to now.

During the discussion which followed, the policy committee decided that:

a. Talmadge (ML) should continue to administer the time, co-ordinating with the new chairman, Rich (AP), and with Helwig (RR).

b. The compiler should have top priority. Ramo-Wooldridge, therefore, would be given all the remaining time, and a good percentage of any more which might be forthcoming.

It was also pointed out that if Remington Rand wished to donate more time, it should be done soon, since the need for this time would disappear as the members received their machines.

5. Rich (AP) volunteered to go through the minutes of this and the previous meetings in order to document the administrative decisions of the policy committee. The document to be prepared will, upon acceptance by the policy committee, replace the document of 22 May 1956 entitled, "A statement of the Basic Policies of the USE organization". This offer was accepted unanimously.

6. During the discussion involving the procedure of mail voting, it was evident that the only serious objection to a mail vote was that those organizations which were vehemently against the item in question could not adequately express their views. Consequently, the item might be accepted without complete consideration.

Rich (AP) suggested that as a matter of operating procedure, a single no in a mail vote, which otherwise would pass in committee, would be sufficient to defeat the item.

In that event, however, it would automatically go on the agenda for the next meeting. This suggestion was adopted, and the Executive Secretary, Kennedy (RR), was instructed to act according to this procedure.

7. Dove (ML) raised a question as to the status of non-voting members; more specifically, he was concerned with the lack of responsibility incumbent upon such membership. From the ensuing commentary it seemed that non-voting members would be able to obtain essentially all the benefits of the USE organization without ever attending a meeting.

Joseph (RR) made the following motion: that a subcommittee be appointed to redefine the status of non-voting members of the USE organization. After some discussion, the motion was seconded and carried. Dove (ML), Cook (BA), Gantner (RW), and Kennedy (RR) were appointed as members of the subcommittee. This subcommittee will report their recommendations to the policy committee at the next USE meeting.

8. Joseph (RR) was appointed a subcommittee of one to arrange for a technical discussion of the file computer, the file computer drum, the card to tape converter, and the verifier at the next USE meeting.

9. Action on committee reports of the previous meeting.

   a. Programming topics Committee: No action pending report of the Program Development committee on commitments for service routines.

   b. Program Development Committee: No action.

   c. Mathematics Committee: Action previously taken. See Minute II.1, Wednesday, 1 January 1957.

10. Action on committee recommendations of the present meeting.

   a. Installation operations committee: Unanimous approval on the text of letters to Remington Rand concerning, (1) The verifier; (2) machine modifications; (3) aids to the machine operator. The text of these letters appears below in Minute II.2, oral report of the chairman of the Installation Operations Committee, Cook (BA). Gantner (RW) appointed a subcommittee of one to draft a letter on the unsatisfactory behavior of the Bull Reproducer.

   b. Mathematics Committee: Ward (HO) appointed permanent chairman, effective 1 April 1957. Ordinary differential equations accepted as topic for next meeting. Honoraria for invited experts was rejected on the grounds that this would be foreign to the voluntary co-operative nature of the USE organization. The keynote speech was discontinued.

11. The session adjourned at 12:05 p.m.

II. General Session, 1:30 p.m.

1. The oral report of the Program Development Committee chairman, Combelic (RW), covered the following points.

a. The idea of a catalogue for USE programs was approved, and a subcommittee with Bitterli (AP) as chairman was appointed to recommend specifications for such a system.

b. Progress on subroutine commitments is satisfactory. About fifteen (15) routines, including five (5) input-output, will shortly be available to all installations; these routines will also serve as the nucleus of the USE subroutine library to be used with the compiler.

c. Specifications for a high speed printer edit routine have been agreed upon. Wright Field has undertaken the task of coding this routine.

d. The Holloman TRANSUSE program has been checked out and is now available.

e. Remington Rand reported progress on a generalized tape handling routine, specifications of which should soon be available.

f. Perkins (RW) reported that the compiler checkout is about 98% complete. For most practical purposes it is now operative, although complete operation according to specifications must be deferred for a short time.

g. Voltin (RR) gave a description of several double precision floating point routines being developed by his organization.

Details of the above points, as well as some points not mentioned, are, of course, given in the written report of the committee chairman.

2. Cook (BA) reported as chairman of the Installation Operations Committee.

a. The committee recommended no changes in the standard USE machine.

b. The following letter on this verifier was drafted for submission by the members to Remington Rand:

"We should like to impress upon you the severe handicap which is being inflicted on design of adequate tape input systems by the absence of tape verifying equipment. On several contemplated systems the speed advantages of tape over cards are being almost completely negated by the non-existance of outlying verification equipment.

It is our understanding that this equipment will be available after July 1957. We earnestly hope that this schedule will not slip and further hope that some acceleration may be possible. Although we understand that Univac users have lived with this equipment deficiency for years, we feel that certain differences in design and operating techniques intensify the handicap on 1103A users.

It is further suggested that a manual describing the operating specifications for this equipment be made available prior to the availability date of the equipment."

c. Discussion of the locking ring situation led to the following letter for submission to Remington Rand by the members.

"The USE organization has been informed that the engineering required to incorporate locking rings on the present 1103A uniservos has been initiated. As members of this organization, we request that the finished product incorporate the following behavior.

If a uniservo is referenced by a write external function instruction when the locking ring is in position, the computer will wait for further action before executing any subsequent commands. In effect this is identical to the behavior previously requested when referencing a tape unit in the "not ready" status.

It is further requested that suitable indication, preferably lights on the uniservo, be provided for this occurrence, and indeed for any reference to a uniservo in a "not ready" status during the execution of a program."

d. A third letter was also drafted concerning aids to the machine operator. It reads as follows:

"At the USE meeting of 9-11 January 1957, in Washington, D.C., a new committee called Installation Operations met for the first time. One of the functions of this Committee was to discuss possible modifications of the 1103A, particularly with respect to indication aids to the machine operator.

The discussion showed that the following items would be desirable as operating features: (1) A light on each uniservo indicating the "write" mode of operation; (2) two rows of five lights on each uniservo to indicate its logical assignment; (3) a bank of lights on each uniservo to indicate its status for any mode of operation; and (4) a bell, under control of a switch on the operator's console, to indicate when the computer stops.

Therefore, we, as members of USE, request that you investigate the possibility of incorporating the above features as integral parts of the 1103A computer."

Again, reference to the written report should be made for details.

3. Much of the oral report of Ward (HO) as chairman of the Mathematics Committee has been covered elsewhere in these minutes. Of importance, however, and not previously mentioned is that specifications for a spectral analysis routine were written (see chairman's report for details) and APL signified willingness to code such a routine if requested to do so by the Policy Committee.

4. After a few concluding remarks by the outgoing chairman, the eighth meeting of USE was adjourned at 3:45 p.m., 11 January 1957.

Respectively submitted

R. B. Talmadge
Chairman, USE

Talmadge

USE ORGANIZATION MEETING

January 9, 10, and 11, Washington D.C.

Report of the Program Development Committee

The Program Development Committee met during the afternoon of January 9, the morning and afternoon of January 10, and briefly during the morning of January 11. The following is a partial list of the persons who attended one or more meetings:

Huntley P. Armstrong, Bureau of Standards
Joan Billerbeck, AP
Charles V. Bitterli, AP
Mr. and Mrs. Cannon, Nuclear Development Corp., White Plains, N.M.
Tom Cooper, RR
Owen Davisson, Frankford Arsenal
Tom Dewey, ML
R. P. Eddy, David Taylor Model Basin
J. F. Eglen, RR
S. H. Eisman, Frankford Arsenal
Leonard B. Fall, WF
Bob Gildea, RCA, Waltham
Dick Gunderson, RR
V. J. Harackiewicz, RR
Constance Holt, AP
Stephen Jarvis, Frankford Arsenal
Leo B. Kennedy, RR
Jerry Knight, Union Carbide Nuclear
Ruth McNaughton, RCA, Waltham
Ben Mittman, RR
George J. Moshos, NACA
Richard S. Murray, AP
Arthur Noma, Army Map Service
John F. O'Connell, American Bosch ARMA
Peter Pastoriza, ORO
Robert Perkins, RW
Harry E. Petersen, WF
Richard H. Petonke, CE
Robert G. Tantzen, HO
George Toal, CE
Bernard Urban, ORO
Irwin Voltin, RR
Arla Weinert, ORO
Fred S. Zusman, AP

Donn Combelic, RW, Chairman

AGENDA

The Policy Committee gave to the Program Development Committee the following agenda:

1. Possible commitments for service routines.
2. Report on high-speed printer generalized edit routine.
3. Progress report on USE Compiler.
4. Progress report on Transuse conversion program.
5. Cataloging of USE programs.
6. Report on Lockheed's matrix abstraction.

The committee tentatively added to this agenda the following items:

7. Recommendations for floating point double precision.
8. Modifications to subroutine requirements.
9. Report on subroutine commitments.
10. Report on tape handlers.
11. Discussion of operating systems.

The Policy Committee asked that the Program Development Committee consider first item number 5, namely, cataloging of USE programs. This matter was considered first with the following results. Tom Dewey (ML) submitted a proposal for categorizing of USE subroutines and programs. After some discussion of this proposal, both pro and con, it was decided to appoint a sub-committee to study the problem and submit a report to the USE Secretary by February 1. Charles Bitterli (AP) was appointed Chairman of this sub-committee. It was agreed that the sub-committee would meet with members of AP and ORO. Briefly the objectives of the sub-committee were spelled out as follows:

1. Expand the definitions in the proposals submitted by Lockheed so as to remove ambiguities insofar as possible.

2. Expand the number of categories as necessary.

3. Whatever method of categorization is selected, determines the form of the index.

4. Determine how it would be updated and circulated.

Certain other points were mentioned, but essentially the sub-committee is to take a whole new look at the problem and come up with a series of recommendations for further consideration.

There was a brief discussion of how USE subroutines might be circulated. There was consideration of cards and of tape and it was finally agreed that the circulation of the manuscript including the subroutine write-up and description and the coding itself would be sufficient for the foreseeable future.

REPORT ON SUBROUTINE COMMITMENTS

The commitments for the various routines are described in detail in the previous Program Development Committee report on page 7. All the routines in question have been coded, several have been checked out and submitted to the ordinary USE channels. Those which have not yet been checked out and submitted are expected to be completed by the next USE meeting.

HSP GENERALIZED EDITING ROUTINE

As reported in the previous committee report, a special sub-committee was appointed to come up with some specifications for a generalized output editing routine. This committee met first in Washington D.C. around the 1st of November with representatives from WF, CE, and AP. In the middle of November a Western group of representatives from HO, RW, BA, and ML met in Palo Alto with Roger Bate (CE) acting as the Eastern representative. The two meetings did result in a compromise proposal which is submitted herewith as appendix 1 of this report. Wright Field has agreed to do the coding on this routine and will put two people working full time on the planning and coding of this program according to the specifications agreed upon. They will give a report of progress at the next USE Meeting.

TRANSUSE CONVERSION REPORT

Robert Tantzen (HO) submitted three reports having to do with the Transuse conversion program. These reports are available through the Executive Secretary of the USE Organization. They are entitled (1) Specifications of the Transuse Conversion Program, (2) Rules for Symbolic Coding of Transuse, (3) Instructions for Machine Operator Using the Transuse Conversion Program. This program has been checked out on the Lockheed 1103A in Palo Alto.

Tantzen reports that they have a side-by-side listing and flow chart of the program, both of which are obtainable on mail request. A bioctal tape will be made available. Tantzen asked for comments and criticisms on the program at any time and also invited any interested party to feel free to visit Holloman after their machine is installed in case they want to use the Transuse Conversion Program. The report was followed by a discussion of some of the details.

REPORT ON LOCKHEED MATRIX ABSTRACTION

Dove (ML) reported briefly on the MAFIA Matrix Abstraction developed by Lockheed. He passed out a write-up describing the system specifications. This write-up is available through the Executive Secretary of USE.

TAPE HANDLERS

Dick Gunderson (RR) reported on RR's generalized tape handler, which routine has now been completely checked out and is available through RR, St. Paul. George Toal (CE) handed out a preliminary write-up of the Corp of Engineers tape control routine. The write-up will be distributed through the USE Secretary as a USEful Note.

USE COMPILER PROGRESS REPORT

Robert Perkins (RW) gave a progress report on the USE Compiler, a formal copy of which is attached as appendix 2 of this report. The Compiler first reached its checked out stage by successfully handling several test problems on the Lockheed 1103A about December 5. Nearly all the features have been tested. The Compiler is now transcribed to its own language and is being re-checked in this form. It will be made available to the other members of USE in the form of a self-loading binary deck. A Compiler Reference Manual is now available and includes the listing of the codes. This Reference Manual is intended to be used by one or more persons at a given installation who must familiarize themselves with the detailed workings of the Compiler.

A subroutine library is not considered part of the USE Compiler, but a minimal subroutine library will be included if so desired. An auxiliary routine will be provided for adding or deleting subroutines to or from the library.

This report was followed by a rather lengthy question and answer period about the compiler details and some discussion of various features. Additional copies of the USE Compiler Programming Manual I were distributed. By the time of the next meeting, RW will have prepared an improved version of this manual which will be complete with examples and contain an appendix wherein fuller explanations of various details will be given.

COMMITMENTS FOR SERVICE ROUTINES

This subject has been discussed at previous USE meetings and no agreement has been reached at any time about the exchange of service routines. After considerable discussion at this meeting, it was agreed that the only apparent way there could be an effective interchange of service routines in the absence of a truly common operational system would be for the service routines to be stripped of their individual system features and the remainder be submitted as a USE Subroutine. Lockheed took the lead in this matter and has agreed to write up their memory dump routine as a USE Subroutine and submit it as a checked out program by the time of the next USE Meeting. It is hoped that this will be a program useful to other installations and that the examples as set will encourage other installations to make their service routines available as self-contained USE Subroutines.

With respect to the general subject of service routines, Betty Holburton of the David Taylor Model Basin described briefly a so-called omnibus tape handling package which is in use at the Model Basin. A copy of the specifications of this successful routine will be made available to the Executive Secretary of USE who will circulate the information. The concensus seemed to be that assignment of coding to any given installation of a tape handling package which would be universally useful would not prove effective.

Kennedy (RR) reports that RR is producing a tape routine which will copy, correct and merge. When the specifications are completed they will be circulated as a USEful Note, which will be followed by a USE Subroutine when the check out is completed.

DOUBLE PRECISION FLOATING POINT

There seem to be two main methods of representing double precision floating point numbers. One of these uses a 54 bit mantissa each word having its own characteristic, one characteristic being 27 less than the other. Another system uses a 62 bit mantissa using one characteristic and 2 sign bits one for each word. Other systems are also under consideration. RR has written routines for handling both types of numbers in an attempt to determine which scheme would lead to the faster interpretation. The routines have been checked out using an interpreter on the Serial 9 1103 in St. Paul. Precise timing checks have not been made, but will be as soon as there is an 1103A available in St. Paul for the use of the RR programming group.

With respect to double precision numbers, a question was raised about the handling of double precision arguments in the accumulator before entering USE subroutines. It was requested that the USE Compiler be modified to provide additional type of calling sequence which would transmit double precision arguments from the accumulator to the USE Subroutine--this sequence would probably be TP LT or LT LT.

Ben Mittman (RR) gave a report on the status of the normalized exit flip-flop instruction. There had been some question by certain members about the function of this instruction. The latest thinking at RR is that the mnemonic code for this instruction will be changed to FR for floating optional round with the following functions. If the j bit is zero, the floating point result is normalized but is not rounded in the 28th bit. In other words, the setting of the normalized exit flip-flop by this instruction, with J = 1, has no effect on floating point operations except to inhibit the final rounding.

MISCELLANEOUS

Some further discussion on operating systems. George Toal (CE) reported that at their installation virtually all of their work will be concerned with only one big problem. Combelic (RW) reported that RW will be running fifty to sixty different problems in a single day. The operational systems at these installations are going to be very different. Charles Bitterli reported on the APL operating system which will have several modes of operation including compiling, correction, interrupt, and normal running. It was pointed out by other people that it was virtually impossible for the USE Organization to agree on developing a common operating system because of the wide diversity of problems presented at the various installations. The opinion was expressed that a common operating system, or rather an operating system used by more than one installation, would come about only because of the adoption by some installations of an operating system successfully used at another installation.

The Program Development Committee will meet in conjunction with the regular USE Organization in Dayton, Ohio, April 24, 25, and 26, 1957.

Respectfully submitted,

Donn Combelic

Donn Combelic, Chairman
March 4, 1957

APPENDIX 1.

USE COMPILER PROGRESS REPORT

January 9, 1957

This report covers progress on the USE Compiler since the USE Meeting in Los Angeles on October 4 and 5, 1956. During this period the following persons at R-W have worked on the compiler: Sue Knapp, Phyllis Van Liew, Rita Summers, and Dave Bussard, full time, and Millard Perstein and Bob Perkins, three-fourths time. The entire staff at Lockheed has been very helpful and cooperative in making their computer and other facilities available.

Coding for the compiler as currently specified is about 98% completed. Check out on the 1103A has been extensive but not intensive. A number of test programs have been successfully compiled. These have involved such features as input from cards, unityper tape or output tape, making insertions, replacements and deletions, generation of item numbers in the various schemes, inclusion of manuscript subroutines, cross reference among subroutines, generation of the compiled region, and production of a binary tape and an output listing tape. Thus the present version of the compiler appears to be able to perform most of the specified functions. Some of the less frequently used loops and in particular various combinations of control words have not been tested as yet.

A first draft of the compiler reference manual, including flow charts, has been written.

The entire compiler, which was originally coded in RAWOOP language, has been transcribed into its own language. This version is currently being compiled and checked. The symbolic listing will be included in the reference manual.

It is planned that in addition to the side-by-side listing, a self-loading binary deck of the compiler will be supplied.

Report Prepared By:

Robert Perkins

APPENDIX 2

1103A High Speed Printer Edit Routine

Specifications

The following specifications for a High Speed Printer Edit Routine were agreed upon at the meeting of the western branch of a special USE Subcommittee in Palo Alto on November 19 and 20, 1956. They are based on recommendations made by the eastern branch of the Subcommittee in Washington on October 30 and 31, 1956.

General.

The Edit Routine edits alphanumeric information from core or drum memory onto magnetic tape in a form suitable for listing on the High Speed Printer. Any of a number of conversion or translation routines may be used to produce the alphanumeric characters for the Edit Routine from the binary data. Both the Edit Routine itself and all conversion routines are standard USE Subroutines and as such are compatible with the USE Compiler. By means of "LOCATE" lines in this code, the programmer will use the compiler to select from the library those conversion routines he wishes to use.

The Edit Routine.

The Edit Routine is a standard USE Subroutine which requires that one argument be transferred into it by the calling sequence and that a parameter list be available. One entry into the Edit Routine is sufficient to produce any number, N, of lines of identical format. Each column in the group of N lines requires two words in the parameter list.

The argument word which is transferred into the Edit Routine by the calling sequence is made up as follows:

```
XX  XXXXX  XXXXX
EF   T N     P
```

P is the address of the first word of the parameter list.
N is the number of lines of identical format to be produced.
T is the servo unit on which the output is to be recorded.
E and F indicate printer control characters as follows:

If $E_{35} = 1$ multiline symbol in each of the N blockettes.
If $E_{34} = 1$ printer stop symbol in the last of the N blockettes.
If $E_{33} = 1$ printer breakpoint symbol in the first of the N blockettes.
If F = 1, 2, 3, or 4 fast speed 1, 2, 3, or 4 symbol in the first of the N blockettes.

The parameter list, stored starting at P, contains a pair of words for each column in the group of lines, followed by an all zero word to signal the end of the list. Each pair of words in the parameter list is made up as follows:

```
XX  XXXXX  XX XXX
D     M    S   W
--  -----  XX XXX
              C
```

W is the number of characters allotted to the column (width).
S is the number of spaces to precede the column on the left.
M is the address of the first word of the data to appear in this column.
D is the increment to be added to M to obtain the addresses of data for succeeding lines of this column.
C is the address of the first cell occupied by the conversion routine which is to operate on the data for this column.

The remainder of the second word of the pair in the parameter list may contain additional information required by the conversion process (such as scaling information) or the address where such information is stored. The precise form of this second word will be specified by the particular conversion routine involved.

The Conversion Routines.

Any number of conversion routines may be available in the library. A "LOCATE" line in the program is used to select each conversion routine needed and to give it a symbolic location, C, by which it is referred to in the parameter list. Each conversion routine is a standard USE Subroutine which requires two argument words. These are the two words from the parameter list with the C (i.e. the V address of the second word) replaced by the address where the output is to be stored. The output will be a series of 6-bit excess three characters. On exit from the conversion routine Q_{35} will be zero if the output characters are packed six to a word. Q_{35} will be one if the output characters are stored one to a word in the rightmost six bits. The leftmost thirty bits will be zero.

January 17, 1957

COMMITTEE REPORT
INSTALLATIONS OPERATIONS COMMITTEE

This committee was appointed by the Policy Committee and met for the first time in conjunction with the eighth meeting of USE at Washington, D.C. on 9-11 January 1957. The purpose of this committee is to gain some insight into the modes of operation contemplated at the various installations particularly with regard to input-output systems. The following is a resumé of the discussion on each of the agenda items as requested by the Policy Committee.

1. Reconsideration of Minimum USE Machine

Reviewing the definition of the minimum USE machine disclosed that a number of the newer members of USE were not aware that the minimum USE machine included the modified off-line High Speed Printer-Plotter. After considerable discussion of this equipment, the consensus of opinion was that the characters on the modified printer are acceptable as being standard. However, some disagreement existed on the horizontal spacing arrangement which is not standard (6 lines/inch). It did not appear necessary nor possible to establish a new standard at this meeting. Individual members were encouraged to negotiate with Remington Rand if they desired spacing other than the 40-20-6 2/3 lines/inch on the existing printer-plotter.

Talmadge (MSD) expressed the opinion that 5 Uniservos did not appear to be a sufficient number for effective operation of the computer and that they plan to increase the number of Uniservos on their computer to ten. A number of other organizations concurred in this opinion. However, it did not appear possible to assure that all members will have more than 5 servos at some future date.

The net outcome of the above discussion was the recommendation that the specifications for the minimum USE machine remain unchanged.

2. Verifier

Because of the importance of this equipment to the integrity of the contemplated computing system, this committee recommends to the Policy Committee that a letter be forwarded to Mr. Wayne Aamoth from each of the USE member installations emphasizing the need for this equipment and urging the most rapid delivery possible. Gantner (Ramo-Wooldridge) was appointed a committee of one to draft the letter (the wording of this letter was later approved by the Policy Committee and is to be distributed by the Secretary). Concern was expressed for the compatibility of this equipment with the modified Unityper. This matter was not pursued further at this meeting.

3. a. Tape Handling in the Absence of the Verifier
   b. The Card-To-Tape Converter

Information on tape handling systems were solicited from each of the installations represented pertaining to contemplated tape handling systems.

Talmadge (MSD) said that in the absence of the verifier they felt compelled to go to a card system rather than tapes. However, after investigating the card-to-tape equipment its inflexibility prohibited its use with the contemplated system. In particular they desired to read two cards in order to write one blockette of 120 characters on the tape. It was suggested that USE pursue the modification of this equipment to provide added flexibility. Since little interest in this equipment was expressed by others it was decided not to pursue this matter further.

Several other installations reported that they planned to use cards as the primary input to the computer. Plans were to read large volumes of cards with the punched card equipment associated with the 1103A. However, a general dissatisfaction with the behavior of this equipment was expressed by the 1103 users. Because these installations are relying rather heavily on the satisfactory performance of this equipment, this committee recommends that the USE organization investigate, in the future, means for correcting the unsatisfactory performance of this equipment.

4. Availability of Uniservo Rings

The question of the availability of tape locking rings to prevent accidental writing was covered adequately by Ted Hellwig in the general session and was not pursued further at this time (more anon). In regard to the requested machine modifications, Earl Joseph added to Ted Hellwig's earlier remarks that complete information regarding the status of these is expected to be available by February 1, 1957.

5. Machine Modifications

A 3-way tape switch was suggested by Dove (MSD) the function of which will permit the set up of the Uniservos for the next job while the computer is operating. At the time the computer is ready to begin the next job it is only necessary to move one switch in order to return the required servos to READY status. Because of the lack of interest in this feature it was not pursued further. A question was raised concerning the functioning of the Uniservo locking ring since this was not described in the available literature. The opinion was ventured that this only disenabled the writing voltages without suppressing tape motion. In order to assure satisfactory performance of this feature, it is recommended to the Policy Committee that all USE members forward a letter to Mr. Wayne Aamoth requesting that Remington Rand modify the Uniservos so that they respond as "NOT READY" when referenced by a write tape command and a locking ring is on the hub and, in accordance with a previous request, halt the computer and, further, in order to provide the machine operator with sufficient information to supply at least one "WRITE" light to inform him when a tape is being written on. Dove (Lockheed) was appointed a committee of one to draft such a letter (the wording of this letter was approved by the Policy Committee and is to be distributed by the Secretary).

A second class of machine modifications was discussed which might be called "added conveniences."

The first of these was two rows of five lights each on each Uniservo to indicate the logical number assigned to each. At the present time, it is necessary to resort to such archaic devices as IBM cards mounted on a paper weight. It was suggested that a device similar to a digital voltmeter might be used which would be easier to read. However, it was felt that this might be too extensive a modification to be requested at this time.

The second modification consisted of lights on each Uniservo to indicate which of the operations (Read, Write, Move, Rewind, Forward, Reverse) are being called for.

Bauer (WF) suggested that a bell might be provided which would call the operator's attention to a computer halt in the event of a programmed stop, fault, external wait, etc. A switch should be provided to suppress the ringing of the bell if it is not wanted.

The member organizations represented unanimously expressed the desirability of these added conveniences and it is recommended to the Policy Committee that each member forward a letter to Mr. Wayne Aamoth expressing our desires in this regard. Dove (Lockheed) was appointed a committee of one to draft such a letter (the wording of this letter was approved by the Policy Committee and is to be distributed by the Secretary).

It was mentioned that, at the present time, it is necessary to perform a "master clear" after rewinding a tape and before removing the tape from the servo. Such an operation is not necessary on the High Speed Printer and the question was raised as to how the 1103A might be corrected. Earl Joseph (RR) volunteered to investigate this matter and submit a report via the USEful Notes.

6. <u>32,000 Word Drum</u>

Spencer (CE) mentioned their machine is to be delivered with 2 logical (32,000 words) drums. An EF command is to be used to switch references to the alternate drums. Little more information was available at this time.

Interest was expressed in this, the card-to-tape, and the File Computer as related to the 1103A tape system. It is recommended that the Policy Committee investigate the possibility of having a Remington Rand representative discuss the technical aspects of this equipment at the next USE meeting.

7. Delayed Program Interrupt

Burlingame (CE) discussed a modification which he has developed for the 1103A which uses an EF command to perform a delayed "Program Interrupt" to facilitate tracing. The affect of this EF command is to cause the computer to jump to F_3 following n instruction executions, n being supplied by the programmer. In the case where $n=1$ a complete trace is effected. However, it is not necessary for the tracing routine to interpret the command just executed thereby increasing the speed and decreasing the storage required. When $n \neq 1$ a selective trace is effected.

Respectfully submitted,

Donald I. Cook

Donald I. Cook, Chairman

Talmadge

Proceedings of the Mathematics Committee of the USE Organization

January 9-11, 1957 Washington, D.C.

The Mathematics Committee met during the regular session of the USE organization at the Shoreham Hotel, Washington, D.C. under the chairmanship of Dr. James Ward. The agenda for the sessions is given in Appendix A. Over 20 persons participated during the span of the meeting, representing 15 organizations (See Appendix B).

Wednesday, January 9, 1957

The keynote address was delivered to the entire USE assemblage of over 75 persons by Mr. Harry Press of the National Advisory Committee for Aeronautics. Mr. Press gave emphasis to the advancing importance of the computations of autocorrelation and spectral density, summarizing the major terms and relationships associated with these concepts. Following this presentation the committee retired to discuss informally the content of the talk and the problems confronting the computation of these functions. Mr. Press demonstrated an extensive familiarity with the topic at hand and ably gave of his many years of experience in this area.

The content of the talk has recently been formalized by Press in conjunction with J. W. Tukey as part of a NATO report on instrumentation. This contribution has been extracted for a Bell Telephone Systems Technical Publication, Monograph 2606, entitled "Power Spectral Methods of Analysis and Application in Airplane Dynamics". This paper is available by request from the Bell Telephone Laboratories.

Thursday, January 10, 1957

The morning session was addressed by Dr. Lee Spetner of the Applied Physics Laboratory of Johns Hopkins University. While Press developed the spectral density theory as the Fourier transform of the autocorrelation function, Spetner gave it a physical motivation in its own right by applying power spectrum analysis. A thorough consideration was given to the problem of digitalizing the problem and the effect of aliasing (folding), resolution and reliability.

Dr. Spetner indicated that he hoped to have this excellent talk mimeographed for more formal distribution.

In the afternoon Werner L. Frank of The Ramo-Wooldridge Corporation presented some numerical results in computing autocorrelation and spectral density according to the estimates of Bartlett and Tukey. Graphs for a number of examples were exhibited. It was pointed out that both estimates appeared statistically to have the same reliability for the cases considered. Also the results were consistent with the reliability limits computed by the techniques of Tukey. Appendix C contains a summary of the theory involved in these computations. This was prepared by Dr. P. Curtis of The Ramo-Wooldridge Corporation and the University of California.

Following Frank, Joseph Carlson of Lockheed Missiles presented his paper, "Transient to Frequency Response", (Appendix D). Mr. Carlson indicated that he hopes that time will be available to him in the future to complete his numerical studies.

At this point a number of business items were considered. The Policy Committee informed us that the Mathematics Colloquium obtained full status as a standing committee and it was necessary to organize more formally. The content of this discussion is reflected in the recommendations made to the Policy group. This is contained in Appendix E.

The balance of the afternoon was spent in discussing the specifications for a complete package program for finding autocorrelation and spectra. (Appendix F) Because of the proximity of Dr. Spetner, Mr. R. Rich of APL suggested that his installation accept this responsibility.

Friday, January 11, 1957

The morning session was devoted to general and open discussion regarding current activities at the various installations. A report of FAP and a matrix package was given by T. Dewey of Lockheed. Also discussed was the complex floating point interpretive routine of APL.

It was suggested that the chairman send a letter to each installation prior to the next meeting requesting a list of mathematical subroutines wanted by each group.

In the afternoon the Policy Committee announced its decision in regard to the recommendations passed to it.

1. The chairman of the Mathematics Committee is James Ward, Holloman.

2. The theme for the next meeting will be Ordinary Differential Equations.

3. The committee is not committed to provide a keynote speaker to the entire USE group at each meeting.

4. No provisions are to be made to make honorariums to speakers.

5. Applied Physics Laboratory will prepare a program for computing spectral density according to the specifications submitted.

Submitted by

Werner L. Frank

Werner L. Frank

Appendix A

USE ORGANIZATION

AGENDA OF MEETINGS OF MATHEMATICS COMMITTEE

Shoreham Hotel, Washington, D.C.

January 8-11, 1956

Theme: Spectral Analysis

Chairman: Dr. James Ward, Holoman Air Force Base

Wednesday, January 9, 1956

1:00 P.M. Keynote Address

"Introduction to Spectral Analysis"

Mr. Harry Press, National Advisory Committee for Aeronautics

3:30 P.M. Discussion of Keynote Address

Thursday, January 10, 1956

9:00 A.M. "General Problems in Spectra"

L. M. Spetner, Applied Physics Laboratory
Johns Hopkins University

12:00 Noon Lunch

1:30 P.M. "Frequency Response from Transient Response"

Joseph Carlson, Lockheed Missiles

3:30 P.M. "Computational Aspects of the Autocorrelation Function and Power Spectra"

Werner L. Frank, The Ramo-Wooldridge Corporation

Friday, January 11, 1956

9:00 A.M. Business

a. Report to Policy Committee
b. Plans for Mathematics Committee

Appendix B

Participants at Mathematics Committee

Werner Frank	Ramo-Wooldridge
Harry Press	NACA
Jim Ward	Holloman
Gray Pyle	White Sands Proving Ground
W. Barkley Fritz	Westinghouse
Richard Zemlin	Remington Rand
Nora Mutin	Remington Rand
Joseph Carlson	Lockheed Missiles
Harry Shaw	APL
Irving E. Gaskill	Corps of Engineers
Michael Tikson	Wright Field
D. P. Squier	Remington Rand
R. McNaughton	RCA Waltham
R. A. J. Gildea	RCA Waltham
V. J. Harackiewiez	Remington Rand
Margaret Cannon	NSA
John F. O'Connell	American Bosch Arma
Bernice Bender	O.R.O.
Lee M. Spetner	Applied Physics Lab.
G. B. Knight	Union Carbide Nuclear Co.

Appendix C

Estimation of the Power Spectrum of a Stationary Stochastic Process

P. Curtis

Let $x(t)$, $-\infty < t < \infty$, be a sample function from a wide sense stationary real values stochastic process with a constant expected value μ. Let $y(t) = x(t) - \mu$, then $E\left\{\left[y(t)\ y(t+s)\right]\right\} = R(s)$ is independent of t and is called the autocorrelation or covariance function of the process. If we assume R(s) is continuous, then R(s) has a representation as a Fourier-Stieltjes transform

$$R(s) = \int_{-\infty}^{\infty} e^{2\pi si\lambda}\, d\left[F(\lambda)\right] .$$

If in addition R(s) is assumed to be integrable on the real line,

$$R(s) = \int_{-\infty}^{\infty} e^{2\pi si\lambda} f(\lambda) d\lambda .$$

The function $f(\lambda)$ is called the spectral density function or power spectrum of the process and is the function we wish to estimate. $f(\lambda)$ is an even, continuous, integrable function. For details of these results see [4], chapter 11.

Suppose we now sample the process at integral values of t obtaining the sequence $x(n)$, $n = 0 \pm 1, \pm 2, \ldots$. Under the assumption that R(s) is integrable, it can be shown that the discrete process x(n) has a spectral density function $f_1(\lambda)$ and that

$$R(n) = \int_{-\frac{1}{2}}^{\frac{1}{2}} e^{2\pi ni\lambda} f_1(\lambda) d\lambda .$$

$f_1(\lambda)$ is obtained from $f(\lambda)$ by essentially "wrapping" $f(\lambda)$ around the unit circle. Explicitly for $0 \leqslant \lambda \leqslant \frac{1}{2}$,

$$f_1(\lambda) = f(\lambda) + \sum_{k=1}^{\infty} \left[f(k-\lambda) + f(k+\lambda)\right] ,$$

$$f_1(-\lambda) = f_1(\lambda).$$

$f_1(\lambda)$ is integrable on $(-\frac{1}{2},\frac{1}{2})$ but is not necessarily continuous.

If we now sample the process $x(t)$ at an arbitrary interval δ, the above formulas become

$$R(n\delta) = \int_{-\frac{1}{2\delta}}^{\frac{1}{2\delta}} e^{2\pi n\delta i\lambda} f_\delta(\lambda)\, d\lambda$$

where

$$f_\delta(\lambda) = f(\lambda) + \sum_{k=1}^{\infty} \left[f(\tfrac{k}{\delta} - \lambda) + f(\tfrac{k}{\delta} + \lambda) \right]$$

$$\text{for } 0 \leqslant \lambda \leqslant \frac{1}{2\delta} \text{ and } f_\delta(-\lambda) = f_\delta(\lambda).$$

As before the function $f_\delta(\lambda)$ is called the spectral density function of the discrete process $x(n\delta)$.

In practical situations one tries to estimate $f(\lambda)$ by first sampling the record of data at a convenient interval δ and then performing some mathematical operations on the sampled data. Once this sampling has been performed it is evident that any estimates are really only estimates of $f_\delta(\lambda)$. Therefore some remarks as to the behavior of $f_\delta(\lambda)$ as $\delta \longrightarrow 0$ are in order. If we define $f_\delta(\lambda) = 0$, $|\lambda| > \frac{1}{2\delta}$, then $f(\lambda) = \lim_{\delta \to 0} f_\delta(\lambda)$ in the mean of order one. If one assumes that $f(\lambda)$ is dominated by a monotone decreasing integrable function one can say more, namely that $f_\delta(\lambda)$ is continuous (except at $|\lambda| = \frac{1}{2\delta}$) and $\lim_{\delta \to 0} f_\delta(\lambda) = f(\lambda)$ uniformly in λ.

Let us return to the case when $\delta = 1$. We wish to estimate $f_1(\lambda)$. This has a Fourier series given by

$$\sum_{-\infty}^{+\infty} R(n)\, e^{-2\pi n i\lambda} = R(0) + 2\sum_{n=1}^{\infty} R(n) \cos 2\pi n\lambda$$

which will not in general converge to $f_1(\lambda)$. In practical situations we can only estimate $R(n)$ as well as $f_1(\lambda)$ since only a finite record of data is available. Let $x(k)$, $k = 1, \ldots N$ be the sample record.

Let $\hat{\mu} = \frac{1}{N} \sum_{k=1}^{N} x(k)$ be the sample mean. Form $\hat{y}(k) = x(k) - \hat{\mu}$, $k = 1, \ldots N$.

Two common estimates of $R(n)$ for $n = 0, 1, \ldots m$ are

$$R_1(n) = \frac{1}{N} \sum_{k=1}^{N-n} \hat{y}(k)\, \hat{y}(k + n)$$

and

$$R_2(n) = \frac{1}{N-n} \sum_{k=1}^{N-n} \hat{y}(k)\, \hat{y}(k + n).$$

For behavior of these estimates in the limit see [6]. In any case the reliability of these estimates decreases rapidly as n increases. Therefore m should be chosen very much less than N. For a discussion of these matters see [2, 5, 6, 7].

The problem of estimating $f_1(\lambda)$ boils down to that of estimating a function for which one has estimates of the Fourier coefficients. Since even in theory the Fourier series does not necessarily converge to $f_1(\lambda)$, some summability method is called for. This amounts to determining multipliers $\lambda_{n,m}$ to be used in estimates of $f_1(\lambda)$ of the form

$$(1) \qquad \lambda_{0,m} R_1(0) + 2 \sum_{n=1}^{m} \lambda_{n,m} R_1(n) \cos 2\pi n \lambda .$$

Here either $R_1(n)$ or $R_2(n)$ may be used for the coefficients. When $\delta \neq 1$, estimate (1) becomes

$$(1') \qquad \lambda_{0,m} \delta R_1(0) + 2 \delta \sum_{n=1}^{m} \lambda_{n,m} R_1(n) \cos 2\pi n \lambda .$$

If $\lambda_{n,m} = (1 - \frac{n}{m+1})$, then (1) becomes the arithmetic mean of the partial sums of the Fourier series estimate of $f_1(\lambda)$, an estimate proposed by Bartlett in [1]. Tukey [7] has proposed multipliers of the form

$$\lambda_{n,m} = .54 + .46 \cos \frac{\pi n}{m} \qquad n \neq m$$

$$\lambda_{m,m} = .04.$$

The actual formula written in the form of (1) for Tukey's estimate at the frequency points $\lambda_k = \frac{k}{2m}$, $k = 0, 1, \ldots m$ is

$$(2) \qquad R_2(0) + 2 \sum_{n=1}^{m-1} (.54 + .46 \cos \frac{\pi n}{m}) R_2(n) \cos \frac{\pi nk}{m} + (-1)^k .08 R_2(m) .$$

That (2) is equivalent to the formula for Tukey's estimate given in [3 or 7] may be immediately verified. For the convergence behavior of (1) under quite general hypotheses see [6].

References

[1] Bartlett, M. S., Stochastic Processes, Cambridge University Press, 1955.

[2] Blackman, R. B., Introduction to the Spectra of Time Series, Bell Telephone Laboratories, Inc., Murray Hill, New Jersey.

[3] Blackman, R. B., Tukey's Recommended Procedure for Computing Power Spectra, Bell Telephone Laboratories, Inc., Murray Hill, New Jersey.

[4] J. L. Doob, Stochastic Processes, John Wiley and Sons, 1953.

[5] Magness, T., Estimating the Power Spectrum of a Stochastic Process, Report No. GM-TN-17, The Ramo-Wooldridge Corporation, Inglewood, California.

[6] Parzen E., "Optimum consistent estimates of the spectrum of a stationary time series", Columbia University, Hudson Laboratories, Project Michael, Tech. Report No. 33, 1955.

[7] Tukey, J. W., "Sampling theory of power spectrum estimates," Symposium on Application of Autocorrelation Analysis to Physical Problems, Woods Hole, Massachusetts, 1949.

Appendix D

MSD - 2059

TRANSIENT TO FREQUENCY RESPONSE

Research Memorandum RM-(66-10)-PA2

4 January 1957

Developed by

J. Carlson

for the USE SPECTRAL ANALYSIS SYMPOSIUM

Lockheed Aircraft Corporation
Missile System Division
Palo Alto, California

MSD - 2059

The numerical method of converting Transient to Frequency Response given herein was developed by the author while acting as a research engineer at the Jet Propulsion Laboratory.

Abstract

A brief review of the mathematical aspects of the frequency response method is given. The paper is concerned with the relation between the Fourier Series and the Fourier integral and the relation between the Fourier integral and the Laplace Transformation.

A numerical method for finding transducer frequency response given the transducers output time history is presented. An RC network is used to illustrate the application of this machine method.

Introduction

The relationship between the discrete amplitude and phase angle spectrum arising in the Fourier series representation of a periodic function and the continuous amplitude and phase angle spectrum arising in the Fourier integral representation of a function that need not be periodic is reviewed. Also considered is the connection between the Fourier integral frequency spectrum and the amplitude and phase angle charts which occur in the Nyquist theory. To point out the fundamentals of frequency response methods, the transfer function of an RC circuit is found using the Laplace Transformation and elementary network theory. The transfer function is then converted to a Fourier frequency function so that phase and amplitude may be determined analytically. A general numerical method (assumes the transducer is excited by a step input) is developed to compute phase and amplitude for an arbitrary transducer output. The method is applied to the RC circuit output and the numerical and analytical phase and amplitude charts are compared.

Fourier Transform

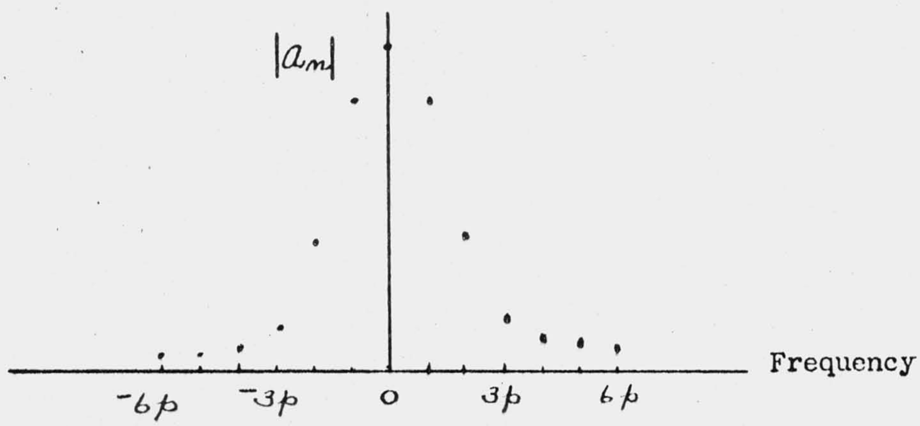
We begin with the complex form of the Fourier Series since it is usually more convenient to work with than the sine and cosine form. The expansion for a time function $E_o(t)$ is given by

$$(1) \qquad E_o(t) = \sum_{-\infty}^{\infty} a_m e^{jmpt} \qquad\qquad p = 2\pi/T$$

where the frequency of $E_o(t)$ is p and the period is T. It is easily verified that the Fourier coefficients a_n are

$$(2) \qquad a_m = \frac{1}{T}\int_{-T/2}^{T/2} E_o(t)\, e^{-jmpt}\, dt$$

It is customary to plot line spectra from equation (2) as follows:



Since a_n is usually complex, a plot of phase as well as amplitude of a_n may be drawn (The discrete curve has been chosen at random to illustrate the method of graphing amplitudes with frequency). Inspection of the amplitude spectrum shows that a facility which transmits faithfully all frequencies up to say $3p$, will reproduce with reasonable accuracy the time function $E_o(t)$.

Equations (1) and (2) could be used in much the same way as the Laplace Transformation is used in the solution of differential equations, but only the steady state solutions would be found in this way. Use of the Fourier series representation of the time functions which occur in differential equations with constant coefficients implies that the transient solutions are not desired. When the periodic solutions of a differential equation are required (see limits of integration in equation (2)), the only solutions one can find are the steady state solutions. When the transient solution is not of short duration, this becomes a serious restriction upon the application of the method. This difficulty is overcome by the introduction of the Fourier integral. The equations (1) and (2) have the form

$$(3) \qquad E_o(t) = 2\pi \int_{-\infty}^{\infty} E_o(\omega j)\, e^{j\omega t}\, d\omega$$

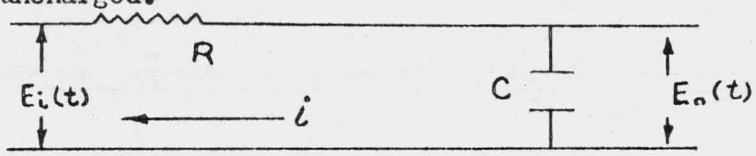
$$(4) \qquad E_o(\omega j) = \int_{-\infty}^{\infty} E_o(t)\, e^{-j\omega t}\, dt$$

when the frequency p approaches zero (the frequency in radians per second ω has replaced the independent variable np).* These equations define the Fourier integral representation of the function $E_o(t)$. The factor 2π has been introduced so that the Laplace Transformation is the same as the Fourier Transformation when s is replaced by ωj . A continuous amplitude and phase angle spectrum could be drawn from $E_o(\omega j)$ in equation (4). The significance, physical interpretation, and use as applied to network response remain exactly the same as the series spectrum.

* "Communication Networks", Guillemin, Vol. II, page 462.

RC Circuit Analysis

The input voltage is assumed to be a unit step and the capacitor is initially uncharged.



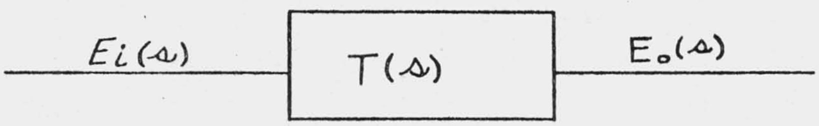
Summing the voltage drops around the circuit

(5) $$E_i(t) = Ri + \frac{1}{C}\int_0^t i\,dt = Ri + E_o(t)$$

Making use of the Laplace Transformation

(6) $$E_i(s) = Ri(s) + \frac{i(s)}{Cs} = Ri(s) + E_o(s)$$

The transfer function T(s) is defined by



In equation form

(7) $$T(s) = \frac{E_o(s)}{E_i(s)} = \frac{1}{1 + RCs}$$

Since the input is a unit step function

(8) $$E_o(s) = \frac{1}{1 + RCs}\,\frac{1}{s}$$

Taking the inverse Laplace Transformation

(9) $$E_o(t) = 1 - e^{-t/RC}$$

Frequency Response

As already pointed out, the Fourier frequency function corresponding to the transfer function of the above RC network is found by replacing s by ωj. The frequency vector $T(\omega j)$ then becomes

$$(10) \qquad T(\omega j) = \frac{1}{1 + RC\omega j}$$

The phase and amplitude of $T(\omega j)$ are

$$(11) \quad \text{amplitude} = (1 + R^2C^2\omega^2)^{-1/2}$$

$$(12) \quad \text{phase} = -\tan^{-1} RC\omega$$

It is now evident that the output frequency spectrum of $E_o(\omega j)$ is reduced in amplitude by the magnitude of $T(\omega j)$ and is decreased in phase angle by $\tan^{-1}RC\omega$. At low frequencies ω, all input frequencies of $E_o(\omega j)$ are passed and there is very little phase shift--the single delay $T(\omega j)$ acts as a low pass filter. It is along these lines of reasoning that the concept of amplitude and phase is used in filter design.

Transient to Frequency Response

The phase and amplitude in equations (11) and (12) are easily found analytically for $E_o(t)$ and $E_i(t)$, but the determination of system characteristics become difficult for more complex transducers. A general numerical method which applies to a system having a step input of amplitude $E_i(N\Delta t)$ and a graphical output time function $E_o(t)$ which settles at $t=N\Delta t$ to the constant value $E_i(N\Delta t)$ is found as follows. Let α be an arbitrarily small positive constant and define X and Y by

(13) $$X - jY = \frac{1}{\Delta t} \int_0^{\infty} e^{-\omega j t} E_o(t)\, e^{-\alpha t}\, dt$$

Making use of the fundamental theorem of the calculus and dropping α

(14) $$X - jY = \sum_{1}^{N} E_o(n\Delta t)\, e^{-\omega j n \Delta t} + E_i(N\Delta t) \sum_{N+1}^{\infty} e^{-\omega j n \Delta t}$$

Part of the right member of the above equation may be simplified

(15) $$\sum_{N+1}^{\infty} e^{-\omega j n \Delta t} = -\frac{1}{2}\left[\sin N\theta \cot\tfrac{1}{2}\theta + \cos N\theta + (\cos N\theta \cot\tfrac{1}{2}\theta - \sin N\theta) j\right]$$

where $\theta = \omega\Delta t$. With this simplification in (14), X and Y become

(16) $$X = \sum_{1}^{N} E_o(n\Delta t) \cos n\theta - \frac{1}{2} E_i(N\Delta t)(\sin N\theta \cot\tfrac{1}{2}\theta + \cos N\theta)$$

(17) $$Y = \sum_{1}^{N} E_o(n\Delta t) \sin n\theta + \frac{1}{2} E_i(N\Delta t)(\cos N\theta \cot\tfrac{1}{2}\theta - \sin N\theta)$$

The amplitude of the input frequency vector is

(18) Amplitude of $\displaystyle\sum_{1}^{\infty} E_i(N\Delta t)\, e^{-\omega j n \Delta t}\, \Delta t = \frac{1}{2} \Delta t\, E_i(N\Delta t) \csc\tfrac{1}{2}\theta$

It follows that

(19) Amplitude of $T(\omega j) = \dfrac{2 \sin\frac{1}{2}\theta}{E_i(N\Delta t)} \sqrt{X^2 + Y^2}$

(20) Phase of $T(\omega j)$ = Phase $(X - jY) + \frac{1}{2}\theta + 90^\circ$

It was planned to include a graph of amplitude versus frequency which would compare the exact amplitude given by equation (11) with the approximate amplitude given by equation (19). Results were not available in time for presentation at the USE meeting. The numerical evaluation of the Fourier integral in equation (13) is not new (see recent journals of the I.R.E.). The writer's contribution is the derivation of equations (19) and (20), using an algebraic rather than a geometric approach.

A few remarks may be stated concerning the form of the data. Eighty equally spaced transient ordinates (N=80) taken from the output trace should be sufficient. A sinusoidal time function will be poorly described if less than four ordinates per cycle are measured from $E_o(t)$. This means that Θ should be taken less than 90 degrees. The $E_o(n\Delta t)$ can always be selected so as to satisfy $-1 \leq E_o(n\Delta t) \leq 1$.

REFERENCES

1. "Frequency Response" Oldenburger

2. "Control System Synthesis" Truxal

3. "Modern Operational Mathematics in Engineering" Churchill

4. "Communication Networks" Guillemin - Vol. II

Appendix E

REPORT OF THE MATHEMATICAL COMMITTEE FOR THE WASHINGTON MEETING

January 9-11, 1957

The theme of this meeting was Spectral Analysis. There were four colloquia and a business meeting. The first colloquium was the keynote address to the entire USE assembly. Attendance at the other meetings ranged from 12 to 22 people. The speakers were:

Harry Press, NACA Langley Field - Keynote speaker

L. M. Spetner, Applied Physics Laboratory

Werner L. Frank, The Ramo-Wooldridge Corporation

Joseph Carlson, Lockheed Missiles

Each of these made very excellent presentations. Few of the committee members knew much of the topic before they came but feel they have learned a great deal. Details of the talks will be given in the minutes of the Committee.

The Mathematical Committee wishes the Policy Committee to take action on the following items:

1. To select a chairman for the Mathematical Committee. The Mathematical Committee nominates

   James A. Ward, Holloman

   David Young, The Ramo-Wooldridge Corporation

   Werner L. Frank, The Ramo-Wooldridge Corporation

2. To select a theme for the next mathematical colloquia. The Mathematics Committee recommends

   a. Ordinary differential equations

   b. Reports on status of the programs of previous themes: curve fitting and frequency analysis

3. To rule on the desirability of the keynote speaker being furnished by the Mathematical Committee at the next meeting, or at each meeting.

4. To rule on the payment of an honorarium to invited speakers. If such is desirable, should it be paid by Remington Rand or by the Host installation?

5. To act on the following recommendations:

   The Mathematical Committee recommends:

   a. An 1103A program from spectral analysis be written to conform with the specification given below.

   b. The task of writing this be assigned to APL (APL has announced willingness to do so.)

James A. Ward - Temporary Chairman

Werner L. Frank - Secretary

Appendix F

SPECIFICATIONS FOR PROGRAM FOR AUTOCORRELATION AND SPECTRAL ANALYSIS

1. The program should follow the Tukey method.

2. The program should be for the minimum 1103A and for core storage.

3. The input and output routines should not be included. The data should be assumed to be in a specified place and the answers be left in a specified place.

4. The data should be limited to 4 decimal digits and all computations should be in fixed point.

5. The number of lags should be left as a parameter.(m)

6. The data storage (N) should follow the lag storage space so that the data storage could be longer for a small number of lags.

7. The output should include the mean, the autocorrelation result, and the spectral density.

8. The coding should be sectional to permit easy modification and insertion by the using installations.

9. Consideration should be given to cross spectrum and pre whitening. Indication should be given if parts of the package can be used for cross spectrum and how pre whitening will fit into the package.

Talmadge

Tentative Schedule for USE Meeting, April 1957.

Wednesday, 24 April 1957:

All day: Policy Committee

Thursday, 25 April 1957:

9:00 General Session

12:00 Lunch

1:00 Committee Meetings

Friday, 26 April 1957:

9:00 Committee Meetings

12:00 Lunch

1:00 Policy Committee

2:00 General Session

Tentative Agenda for April Meeting.

A. Policy Committee

1. Approval of minutes

2. Set final agenda

P 3. Action on committee reports from last meeting

P 4. Report of subcommittee on definition of non-voting members (Don Gantner).

P 5. Revised statement of policies

P 6. New Committee chairmen

P 7. Scope of Useful notes (Ltr. Kennedy 2/11/57).

P 8. Distribution of revised committee reports (Ltr. Kennedy 2/22/57).

P, O 9. Action on Bull (Gantner).

P 10. Action on committee reports from this meeting

P 11. Status report on Programming Manual

G.S. 12. Status report on machine modification requests

B. Program Development Committee

PDC 1. Catalog of USE routines

PDC 2. Method of revision of USE routines (3/11/57)

3. Collect and formalize standards for coding and writeup

4. Recommend action on Burlingame's programmed program interrupt

PD 5. Progress reports:
   a) USE Compiler
   b) Generalized Print Edit Routine

PD 6. Perkins' Letter

C. Mathematics Colloquium

1. Ordinary Differential Equations

2. Report on curve-fitting routines

3. Report on frequency analysis routine

D. General Session

1. Announcement of Agenda

2. Announcement of committee chairmen

3. Univac File Computer (W. Sheldon Lewis)

4. Card to tape converter (Richard Acuff)

To Policy Committee Members:

The attached "Statement of Policies" has been submitted by R. P. Rich for the consideration of the Policy Committee.

W. E. McVicar

W. E. McVicar
Executive Secretary, USE
Remington Rand Univac
Univac Park
St. Paul 16, Minnesota

WEM:lps

Statement of Policies

1. Name.

This organization will be known as the Univac Scientific Exchange (USE).

2. Purposes.

The purposes of USE are:

2.1 Exchange of ideas and information concerning programming and coding for the 1103A.

2.2 Coordination of voluntary preparation of routines of common interest, and of a common language for their exchange.

2.3 Recommendation of machine changes and additional equipment.

3. Voting Membership.

Membership in USE is voluntary and by installation. An installation becomes a voting member upon presentation to the Executive Secretary of

a) application for membership, and

b) evidence that the installation now owns or rents an 1103A or has placed a firm order to do so.

4. Non-Voting Membership.

To be reconsidered at April Meeting.

5. The officers of USE shall consist of a Chairman and an Executive Secretary. Each must be a member of a voting member installation. Each is elected by a plurality vote of the Policy Committee for a term of one year beginning 1st April.

6.1 The Chairman will officiate at all general sessions of USE meetings. He will be responsible for the preparation of a tentative agenda for each meeting of USE and will submit it to the Executive Secretary for reproduction and distribution to the membership before the meeting.

6.2 The chairman will also serve as chairman of the Policy Committee and will be a member ex officio of all other USE committees.

6.3 The chairman may appoint a chairman pro tem at any time.

6.4 The chairmanship will not remain with the same member installation for two consecutive years.

7. The retiring chairman will be an ex officio member of the Policy Committee for a period of one year after quitting office unless, at the option of his installation, he becomes the regular representative of his installation during that same period.

8.1 The Executive Secretary will reproduce and distribute the minutes of meetings, committee reports, the tentative agenda for USE meetings, reports of USE routines, Useful Notes, and such other items as the Policy Committee may direct.

8.2 He will process applications for membership in accord with Sections 3 and 4 and requests for attendance at meetings in accord with Section 9.

8.3 He will be an ex officio member of the Policy Committee and will provide at each meeting a complete reference file of official USE records and correspondence.

8.4 He will serve as Chairman of the Publications committee and in that capacity may refuse to distribute through USE channels anything which does not meet the standards set up by USE.

9. General meetings of USE will be held at the discretion of the Policy Committee. Remington Rand will act as host at the meetings, will provide suitable accommodations for the meetings, and will make housing arrangements or provide information concerning available housing.

Each member installation in turn will act as host installation and will provide a recording secretary, who shall be a stenographer.

Any member installation may invite guests to general USE meetings subject to approval by the chairman and any special requirements established by the Policy Committee.

10.1 The governing body of USE is the Policy Committee. It consists of one representative from each voting member installation, the chairman of USE as chairman, and ex officio members as specified in Sections 7 and 8.

10.2 It is the responsibility of the Policy Committee to guide the activities of USE into productive channels. All authority for decision in USE matters resides in the Policy Committee unless explicitly delegated by that body.

10.3 Meetings of the Policy Committee will be closed, except that by a majority vote of the committee particular sessions may be open to the public or to specified individuals.

10.4 The Policy Committee will make up the final agenda for each meeting and assign items to committees. It will consider all committee recommendations and decide on the action to be taken.

10.5 The Policy Committee will meet at each general USE meeting, and may meet at other times at the discretion of the chairman.

11. A quorum of the Policy Committee will consist of the voting members present at a meeting held concurrently with a general USE meeting, and will consist of at least 60% of the voting membership at any other meeting.

At least 2/3 "yes" and no more than 1/4 "no" of those present shall be required to pass a motion in the Policy Committee. Election of officers is by plurality vote, as specified in Section 5.

12.1 The Policy Committee may form and disband working committees as the need arises. Such committees will consider any agenda items assigned to them as described in Section 10, and may at the discretion of the committee chairman consider other items in the same general field.

12.2 Each chairman of an active committee will make an oral report to the general USE meeting which will outline the subjects discussed and will contain the recommendations of the committee.

12.3 Each chairman will also submit a written report to the Executive Secretary within a reasonable time after the meeting for distribution to the members of USE. If, upon receipt of the written report of the chairman, any member of the committee feels that it is incomplete or erroneous, he will communicate directly with the committee chairman, who will submit an amended report to the membership at the next meeting.

12.4 These committees will normally meet concurrently with the general USE meeting. The chairman of the committee may call a meeting at any time providing that at least one week's notice is given to each committee member for each meeting that is not held during a general USE meeting.

12.5 Meetings of these committees will normally be open, and invited guests may participate by direction of the chairman.

12.6 Terms of committee chairmen will end on the 31st of March following appointment. A committee chairman may be reappointed.

12.7 There are at present three standing committees: The Program Development committee, the Publications committee, and the Mathematics ~~Colloquium~~. COMMITTEE

13. The function of the Program Development Committee is to exchange programming ideas, information, and techniques, and to avoid duplication of effort where possible by voluntary cooperation in programming work.

14. The function of the Publications Committee is to set up and maintain proper standards of communication between member installations through USE channels. Each installation will have a member of the Publications Committee, who will be responsible for seeing that any material submitted to USE from his installation meets the relevant standards.

15. The functions of the Mathematics ~~Colloquium~~ are: 1) exchange of working codes for mathematical subroutines; 2) description of working experience with existing mathematical subroutines; 3) discussion of promising mathematical methods with the idea of developing subroutines using these methods; 4) preparation of specifications for mathematical subroutines and recommendation of a member installation to provide a working machine program.

The Colloquium will have a general subject for each meeting chosen by the Policy Committee, usually upon recommendation of the Colloquium.

Talmadge

High Speed Printer Edit Routine

Wright Field Progress Report
19 April 1957

The High Speed Printer Edit Routine has been written and punched on cards in preparation for checking on an 1103A. Some preliminary checking has been done on the Wright Field 1103. In addition, an octal conversion routine has been written, punched on cards, and also partially checked on the Wright Field 1103.

Some modifications have been made in the specifications produced by the USE Subcommittee at Palo Alto in November 1956. No further modifications are anticipated. The following specifications for the off-line fixed block version are therefore expected to be final.

Edit Routine

The Edit Routine is a standard USE subroutine which edits alphanumeric information from core or drum memory, preparing magnetic tape suitable for listing on the off-line High Speed Printer. Any of a number of conversion or translation routines may be used to produce the alphanumeric characters for the Edit Routine from binary data.

The Edit Routine requires that one argument word be transferred into it by the calling sequence and that a parameter list be available. One entry into the Edit Routine is sufficient to produce any number of lines N, less than 1000, of identical format. Each column in the group of N lines requires two descriptive words in the parameter list.

The argument word which is transferred into the Edit Routine by the calling sequence is made up as follows:

```
X X  XX XXX  XXXXX
F E  T   N     P
```

- P is the address of the first word of the parameter list.
- N is the decimal number of lines of identical format to be produced. $(1 \leq N \leq 999)$
- T is the decimal number of the servo unit on which output is to be recorded. $(1 \leq T \leq 10)$
- E and F are octal digits which indicate that printer control characters are to be written as follows:

  If $F = 1, 2, 3$, or 4, a fast feed 1,2,3, or 4 symbol is placed in the first of the N blockettes.
  If $E_{32} = 1$, a multiline symbol is placed in each of the N blockettes.
  If $E_{31} = 1$, a printer breakpoint symbol is placed in the first of the N blockettes.
  If $E_{30} = 1$, a printer stop symbol is placed in the last of the N blockettes.

A block of information is written on tape as soon as it is complete.

A change in the specified servo unit will cause the Edit Routine to write a partially filled block if it exists before this change is accomplished.

When special symbols are to be written, the total number of characters available for blockette construction is 120 minus the number of symbols used.

The parameter list which is stored beginning at address P contains a pair of parameter words for each column followed by a pair of control words P_1 and P_2 to signal the end of the list. P_1 is always zero. If $P_2 = 0$, a partially filled block is not written at the end of N blockettes. If $P_2 \neq 0$, a partially filled block is written at the end of N blockettes.

Each pair of words in the parameter list is made up as follows:

```
XX  XXXXX  XXX XX
D     M     W   S

--  -----  XXXXX
             C
```

- W is the decimal number of characters allotted to the column. $(1 \leq W \leq 120)$
- S is the decimal number of spaces to precede the column. $(0 \leq S \leq 99)$
- M is the address of the first word of data to appear in this column.
- D is the octal increment to be added to M to obtain the addresses of data for succeeding lines of this column.
- C is the first address occupied by the conversion routine which is required for data in this column.

The remainder of the second word of the pair may contain additional information required by the particular conversion routine, such as scaling, or the first address of additional information required. The precise form of this word will be specified by the particular conversion routine.

The Edit Routine generates a calling sequence which transfers this pair of parameter words into the particular conversion routine with the address C replaced by the address at which the conversion routine is to store W results.

Conversion Routines

Any number of conversion routines, which are also standard USE subroutines, may be available in the library. A "LOCATE" line in the program is used to select each conversion routine required and to assign a symbolic location, C, designated in the parameter list. Each conversion routine requires two argument words, which are transferred into it by the Edit Routine. These two arguments are the two words in the parameter list with C (i.e., the v address of the second word) replaced by the address at which the conversion routine is to store W results.

The results from the conversion routine will be a series of 6-bit excess three characters. On exit from the conversion routine Q_{35} will be zero if these characters are packed six to a word. Q_{35} will be one if these characters are stored one to a word in the rightmost six bits, with the leftmost thirty bits being zero.

Talmadge

1103A MODIFICATIONS

REQUESTED BY USE ORGANIZATION

23 April 1957

REMINGTON RAND UNIVAC
Division of Sperry Rand Corporation
St. Paul, Minnesota

FUNCTIONAL DESCRIPTION OF 1103A MODIFICATIONS
(Requested by USE Organization)

Modifications Which Will Be Performed at Remington Rand Univac Expense

1. Uniservo "Not Ready" - The Tape Control Unit (TCU) will be modified to simplify starting the operation of a given Uniservo if it is probed when "not ready". The Uniservo "not ready" condition will be changed from a B-Fault to an Input/Output Lockout. The following results would ensue:

Cause of "Not Ready" Condition	Result
a. power off	wait on current EF
b. attempted write on ringed tape	wait on current EF
c. door open (changing tapes)	wait on next ER, EW, or EF (retaining select bits in TCR)
d. logical selection of Uniservo not made	wait on next ER, EW, or EF (retaining select bits in TCR)

In addition, one light on the control console would indicate that a Uniservo had been referenced in the "Not Ready" state.

The modifications to the tape control (70,000 cabinet) would provide a different type of computer stop. "Not Ready" condition would be changed from B-Fault to a computer wait. The cause of "Not Ready" condition can be corrected and the program resumed without a master clear of the central computer.

2. Modify Tape Change Procedure - To provide tape change without the requirement of "Master Clear", recovery from the rewind lock is automatically provided.

3. "Immediate" B-Fault Stop - To eliminate operational difficulties associated with card and tape input/output equipment, a change is proposed to provide a stop as soon as possible to the computer operation upon detection of a B-Fault.

An external fault path for pulses from the B-Fault detection circuitry will be added. By resynchronizing the D-C line now present as an External Fault, a stop pulse would directly trigger the stop flip-flop. This additional path eliminates the relay actuation time now required to stop the computer. This system would operate as soon as a fault pulse has been produced either internally or by an input/output device.

Modifications Offered to the USE Organization at USE Members Expense

1. Additional Indicator Lights to Lineprinter Uniservo - The logical assignment of each Uniservo would be indicated by an in-line digital read out unit controlled by a third deck on the logical selection switches. The operator's indicators will be neons operated from the circuits peculiar to each Uniservo. The panel will resemble Uniservo II in the styling and electrical characteristics.

2. Addition of a Computer Stop Signal Bell - The proposed system would add a bell under the control of an on-off switch on the operator's console to indicate that the computer had stopped, whether the stop be a programmed stop, a computer fault, or an internal or external wait.

The proposed system would add a re-triggerable delay flop (1-shot multi-vibrator) with a period of 5 seconds. This circuit would be triggered by each "Advance PAK" pulse. The output would energize a relay, which controls the signal bell.

3. Modify Present Overflow Stop - The proposed system would change the over-flow stop for the Multiply-Add, divide check stop, and characteristic overflow (floating point operations) to a non-computer stop. In the above cases, the Program Control is transferred to a fixed address (F-5). The following sequence of oper-ations occur:

1. Stop the Computer
2. Clear ASC
3. Clear SAR
4. Set MPD to 7
5. Wait two microseconds
6. Set SAR to F-5
7. Initiate a Read subcommand and supply a resume to clock rate control.

An operator's control would be added to switch the new feature on and off.

4. "Abnormal to Normal Drum" Instruction (Instruction Code 06) - To facilitate starting of the loading routine, a new instruction is proposed. This instruction is to change the abnormal drum setting to the normal drum setting automatically. This instruction is normally used after the loading routine (stored in the abnormal drum section) is transferred to the high speed storage. The use of this instruction would allow a complete loading sequence from the start of the computer by the operator without manual intervention. Circuitry is added to replace a relay which controls the Coincidence Lockout flip-flop. This flip-flop is set manually by the abnormal drum switch. Clearing of this flip-flop to the normal drum portion is by a master clear or by instruction code 06. Only the operation code is used, the U and V addresses are ignored.

5. Add Two Inter-Change Instructions (Instruction Codes 10 and 20) - It is proposed to add two instructions, the first to place the U portion of a given word into the V portion of a second word and the second instruction to place the V portion of a given word into the U portion of a second word. In both cases the remainder of the word is not to be disturbed. The 10 instruction will place the U portion of (U) into the V portion of (V).

1. Read (U) into X register.
2. Interchange the U and V portions of the X register.
3. Transmit VAK to SAR.
4. Partial write the low order bits (0 through 14) of the contents of the X register in the memory address currently stored in SAR.

Instruction Code 20 is added to place the V portion of (U) into the U portion of (V).

1. Read (U) into X register.
2. Interchange the U and V portions of the X register.
3. Transmit VAK to SAR.
4. Partial write the middle order bits (15 through 29) of the contents of the X register in the memory address currently stored in SAR.

STATUS OF 1103A PROGRAMMING MANUAL

The writing of the manual has been divided into three parts: the central computer, input-output, and magnetic tape. The final manuscript on the first part will be turned over to the Sales Department and USE members for editing by May 1st. This will be followed by the final manuscript on the input-output section excluding magnetic tape by May 10th.

Tests to determine optimum programming time on the fixed block mode for magnetic tapes are now being performed. The results of these tests will be incorporated in the complete description of magnetic tapes.

A manuscript of magnetic tape will be furnished to the Sales Department and USE members for editing by the end of May, according to present plans.

April 17, 1957

Information Science Department

Research Division

Remington Rand Univac

Talmadge

April 29, 1957

USE Members:

The following is an attendance list for the USE Meeting at Dayton:

Holloman Air Development Center:

M. Green	J. Ward
B. McCrossen	R. Tantzen

John Hopkins University/APL:

R. Rich	H. Shaw
A. Stone	

Boeing Airplane Co.:

D. Cook	R. Carriker

Lockheed Missiles:

R. Talmadge	T. Dewey
B. Dove	R. Rudin

Wright Air Development Center:

Cryan	Bausnan
Atwood	Graham
Toney	Blanch
Tikson	Williams
Fall	Fonars
Bauer	Clemm
Thomas	Smith
Fettis	Miller
Brown	Edwards
Peterson	Harrison
Hill	Valentine

Ramo-Wooldridge Corp.:

D. Gantner	W. Frank
D. Combelic	B. Perkins

John Hopkins University/ORO

G. Clark	Pastoriza
Taylor	Weinert

Corps of Engineers:

J. Spencer

Bureau of Census:

D. Heiser
B. Shafer
D. Armstrong

White Sands Proving Grounds:

N. Ingram
G. Pile
L. Graham
R. Bigelow

Eglin Air Force Base:

D. Todd

California Texas Oil Co.:

R. DeBiase

American Bosch Arma Corp.:

C. Tross
J. O'Connell

Arnold Engineering Development Center:

J. Chapek

RCA:

V. Harackiewicz

Frankfort Arsenal:

R. Brown

Atlantic Refinery:

A. Hasbrook

University of Michigan:

J. Carr

Remington Rand:

R. Acuff
J. Hales
P. Desilets
R. Dravin
T. Hinkes
N. Schneidewind
E. Haight
R. Schmidt
D. Zemlin
T. Wilder

Remington Rand:

M. Bass
R. Simon
J. Egler
T. Cooper
H. Fitzgibbon
W. Aamoth
J. Burke
A. Medica
I. Voltin
G. Etsell
B. Mittman

Any additions or corrections to this list would be appreciated.

Very truly yours,

W. E. McVicar

W. E. McVicar
Executive Secretary, USE
Remington Rand Univac
Univac Park
St. Paul 16, Minn.

WEM:lps

Talmadge

1 May 1957

USE
INSTALLATION MAILING LIST

(HO)
Commander, Holloman Air Development Center
Attention: HDRS, (Name)
Holloman Air Force Base, New Mexico

(BC)
U. S. Dept. of Commerce
Bureau of the Census
Washington 25, D. C.

(AP)
Johns Hopkins University/APL
8621 Georgia Avenue
Silver Springs, Maryland

(BA)
Digital Computing Group
Physical Research Staff
Boeing Airplane Company
P. O. Box 3707
Seattle 24, Washington

(ML)
Lockheed Missiles
Plant 2
P. O. Box 504
Sunnyvale, California

(WF)
Commander, Wright Air Development Center
Wright-Patterson Air Force Base
Dayton, Ohio
Attention: (Name)
Attention: WCRRU

(RW)
Ramo-Wooldridge Corporation
Digital Computing Center
5760 Arbor Vitae Street
Los Angeles 45, California

(OR)
Johns Hopkins University/ORO
7100 Connecticut Avenue
Washington 15, D. C.

(CE)
Washington District Corps of Engineers
1st and Douglas Streets, N. W.
Washington, D. C.
Attention: (Name)
Attention: Mathematical Computation Div.

Office,
Chief of Engineers
Washington 25, D. C.
Attention: ENGBH

(RR)
Remington Rand Univac
Univac Park
St. Paul 16, Minnesota

USE DISTRIBUTION

PUBLICATIONS COMMITTEE - (5 copies each)

W, E. McVicar	(RR)
D. Combelic	(RW)
D. Cook	(BA)
R. G. Tantzen	(HO)
B. Dove	(ML)
R. P. Rich	(AP)
W. B. Taylor	(OR)
F. Bauer	(WF)
J. W. H. Spencer	(CE)
D. P. Armstrong	(BC)

INSTALLATION HEADS - (1 copy of Minutes and Committee Reports and Tentative Agendas)

W. F. Bauer	(RW)	
R. E. Porter	(BA)	
M. C. Green	(HO)	
W. Leutert	(ML)	
R. P. Rich	(AP)	
C. Fluke	(WF)	
H. B. Horton	(CE)	National Damage Assessment Center Office, Devense Mobilization Executive Office of the President Washington 25, D. C.
G. Clark	(OR)	
D. H. Heiser	(BC)	

NON-VOTING MEMBERSHIP - (1 copy each minutes)

(SD)

J. B. Rosen
Applied Math. Group
Shell Development Company
Emeryville, California

(NS)

Mrs. Dorothy T. Blum
4314 North Pershing Drive
Arlington 3, Virginia

(BS)

J. Wegstein
Computation Laboratory
National Bureau of Standards
Washington 25, D. C.

(CT)

D. C. Holmes
California Texas Oil Company, Ltd.
380 Madison Avenue
New York 17, New York

(NS)

G. W. Lerch
National Security Agency
1929 S. Quebec St.
Arlington 4, Virginia

NOTE: SEND ONE (1) COPY OF MINUTES OF USE MEETING TO EACH PERSON ATTENDING IF ATTENDANCE LIST IS SUBMITTED.

Remington Rand Univac (All USE Material)

(1)	Frank Kros	St. Paul - File Computer Center
(1)	B. D. Smith	St. Paul - Plant 1
(1)	W. S. Lewis	St. Paul - File Computer Center
(1)	N. E. Albrecht	St. Paul - Plant 2
(2)	E. C. Joseph	St. Paul - Plant 6
(1)	R. C. Gunderson	St. Paul - Plant 6
(1)	I. V. Voltin	St. Paul - Plant 1
(1)	W. B. Wallace	St. Paul - Plant 2
(1)	P. Desilets	St. Paul - Plant 6
(1)	D. Zemlin	St. Paul - Plant 6
(1)	E. Haight	St. Paul - Plant 6
(2)	B. Cheydleur	St. Paul - Plant 6
(1)	P. Zimmer	St. Paul - Plant 4
(1)	G. Lunger	St. Paul - Plant 3
(1)	Jean Hansen	St. Paul - Plant 6
(1)	D. Messerich	St. Paul - Plant 4, Room 308
(1)	L. Krider	St. Paul - Plant 6
(1)	D. Powellek	St. Paul - Plant 4, Room 312 (Engineering)
(1)	R. D. Schmidt	St. Paul - Plant 4, Room 311 (Engineering)
(1)	L. D. Dominick	St. Paul - Plant I (Electronic Services)
(1)	L. B. Kennedy	St. Paul - Plant 2
(2)	C. F. Crichton	St. Paul - Plant 6

USE Organization

POLICY COMMITTEE

Bernard Dove - (ML)

Donald Gantner - (RW)

Donald Cook - (BA)

Marvin Green - (HO)

Alex Stone - (AP)

Demetrius Zonars - (WF)

John W. H. Spencer - (CE)

George Clark - (OR)

Leo Kennedy - (RR)

Don Heiser - (BC)

OFFICERS

Chairman: R. P. Rich - (AP)

Secretary: W. E. McVicar - (RR)

Talmadge

MINUTES OF THE USE POLICY COMMITTEE

DAYTON MEETING 24-26 APRIL 1957

Wednesday Morning, 24 April.

The Policy Committee came to order at 9:30 with the following members present:

R. P. Rich (AP) Chairman
R. B. Talmadge (ML) Past Chairman
W. E. McVicar (RR) Executive Secretary
D. I. Cook (BA)
B. C. Dove (ML)
J. W. H. Spencer (CE)
D. W. Gantner (RW)
M. Green (HO)
D. Zonars (WF)
L. B. Kennedy (RR)
A. G. Stone (AP)
G. E. Clark (OR)
D. H. Heiser (BC)

Upon assurance by Remington Rand that the Bureau of Census will purchase two 1103A's, this organization was welcomed as a member of USE. They will use BC as their initials and are represented on the Policy Committee by Donald H. Heiser.

By unanimous agreement, the last year's chairman, R. B. Talmadge, was commended for his fine conduct of the office.

At the request of Remington Rand, L. B. Kennedy was replaced by W. E. McVicar as Executive Secretary to become Remington Rand's voting representative in the Policy Committee.

Item A1. The minutes of the previous meeting were corrected as follows:

a) Installation Operation Committee Report, page 2 paragraph 4, sentence reading "In regard to requesting machine modifications, Earl Joseph added to Ted Hellwig's earlier remarks ... "read "repeated" instead of "added to."

b) G. E. Clark (OR) was added to the list of those present.

c) Policy Committee Report, page 3 paragraph 1, for "Spencer (CE) nominated Rich..." read "Gantner (RW) nominated Rich... ."

d) Program Development Committee Report, page 3, in the report on Lockheed Matrix Abstraction, delete the sentence reading "This writeup is available through the Executive Secretary of USE."

e) Ibid, paragraph on Tape Handlers, for "has now been completely checked out and is available" read "will be available."

Item A2. The agenda for the meeting was determined as follows:

AGENDA FOR APRIL MEETING

A. Policy Committee

1. Approval of minutes
2. Set final agenda
3. Action on committee reports from last meeting
4. Report of subcommittee on definition of non-voting members
5. Revised statement of policies
6. New committee chairmen
7. Scope of Useful Notes
8. Distribution of revised committee reports
9. Action on Bull
10. Action on committee reports from this meeting
11. 20 hours for USE of additional free time
12. Mathematics Committee
13. Date and Place of next meeting

B. Program Development Committee

1. Catalog of USE routines
2. Method of revision of USE routines
3. Collect and formalize standards for coding and writeup
4. Recommend action on Burlingame's programmed program interrupt
5. Progress reports:
    a) USE Compiler
    b) Generalized Print Edit Routine
    c) Coding Assignments
6. Double precision floating point
7. Use of IP instruction
8. Card output routine for compiler

C. Installation Operations Committee

1. Acceptance Tests and performance standards
2. Availability and use of drum dead space
3. Operating experience to date

4. Spare parts availability
5. Plastic tapes and improved servos
6. Buffering System
7. Action on Bull
8. Status reports of machine modifications
9. Master Clear

D. Mathematics Committee

1. Ordinary differential equations
2. Report on curve-fitting routines
3. Report on frequency analysis routine

E. General Session

1. Announcement of Agenda
2. Announcement of committee chairmen
3. Univac File Computer (Wes Knutson)
4. Card to tape converter (Richard Acuff)
5. Status of Programming Manual
6. Status of Machine Modifications
7. Policy Committee Report
8. Reports of Committee Chairmen

Item 3. No action on the committee reports of the last meeting was necessary.

Item 4. At the January meeting a subcommittee of the Policy Committee was appointed to consider the Definition of Non-Voting Members. This subcommittee, consisting of Dove(ML), Cook(BA), Gantner(RW), Kennedy (RR), met at the Van Cleve Hotel on April 23rd. It was decided that there should be no change in the definition of basic policies. It was agreed that each USE member, and in particular Remington Rand sales personnel, should continue to use discretion in inviting guests to meetings. Further discussion of non-voting members was deferred to agenda item 5.

Item 5. Revised Statement of Policies.

As agreed at the January meeting, the chairman prepared a new Statement of Policies, which was circulated in advance of the present meeting. A full discussion of this document resulted in a revised version for discussion at the July meeting. Certain salient points of the discussion are summarized here. Reference is made to the original Statement of Policies of the Univac Scientific Exchange adopted 22 May 1956 and to the Revisions made therein at the meeting of October 4-5, 1956 as recorded in the appendix of the Policy Committee minutes for that meeting.

a. The purpose of the organization is best expressed in the original Statement.

b. The method of admission of non-voting members shall remain as in the original Statement.

c. Visitors may be invited to a USE meeting by any voting member organization and by Remington Rand Univac Sales Department. The number of invitees and, if possible, their names and organizational affiliation must be submitted to the Chairman and RR Sales prior to the meeting which they are to attend.

d. The Chairman and Executive Secretary are each elected by a majority vote of the Policy Committee.

e. The paragraph reading "The chairmanship will not remain with the same member organization for two consecutive years" was discussed; it was decided to leave the paragraph in until the final voting in July.

f. The Executive Secretary will make available to RR-Sales, to use as they see fit: membership lists of the USE organization, specifications and descriptions of routines available to USE members, and such other items as the Policy Committee may from time to time direct.

g. The Policy Committee will meet at each general USE meeting and may meet at other times at its discretion.

Item 6. The Installation Operations Committee was made a standing committee with Cook(BA) as chairman. Combelic(RW) and Ward(HO) will continue as chairmen of the Program Development and Mathematics Committees, respectively.

Item 7. Kennedy(RR) stated that Remington Rand preferred to circulate information concerning the basic operation of the 1103A through its field representatives or by letter rather than through Useful Notes. This statement arose from the request at the January meeting for information on the need for a master clear before tape rewind and information on the floating point instructions to be supplied via Useful Notes.

It was agreed that although the Useful Notes are available to Remington Rand as to other USE members, the use of this medium rather than another was a matter of choice.

Item 8. It was agreed that when a revision or correction is made to a USE Committee Report it is not necessary to circulate the revised report in toto, but rather to circulate an errata sheet to be appended to the original report by each recipient.

Item 9. Gantner(RW) distributed a draft of a letter on the Bull Reproducer to be sent to Mr. Aamoth. It was decided that Gantner(RW), Dove(ML), and Talmadge(ML) would draft a new letter to be considered at the Policy Committee Meeting on the 26th. At that time the new letter was approved for submission to member organizations through the usual channels for signature and transmittal to Remington Rand Sales.

The question of performance of this equipment was referred for fuller discussion to the Installation Operations Committee (as Item C 7).

Item 10. Action on Committee Recommendations at this meeting.

a. Mathematics Committee.

The Mathematics Committee submitted the following recommendations:

1) That installations be informed of the Transuse feature permitting standard USE language floating point routines to be converted to a program which will run on a fixed point machine.

2) That the format, structure, and distribution of subroutines and general program packages be clarified.

3) That Ramo-Wooldridge prepare a floating point routine for solution of ordinary differential equations with the following features:

i) use of Runge-Kutta as a starting procedure.

ii) option of continuing Runge-Kutta or of switching to Adams-Moulton at any time step.

iii) automatic halving or doubling of time step if Adams-Moulton is used.

iv) partial double precision operation.

4) That Wright Field investigate Dr. Blanche's method of solving differential equations by using integral equations.

5) That Remington Rand prepare a code employing the Gaussian quadrature techniques.

6) That Wright Field continue Dr. Blanche's investigation of truncation and roundoff errors.

(The Mathematics Committee Chairman stated that the organizations mentioned in the above recommendations had agreed to undertake the tasks there described.)

7) That the topic for the next meeting be eigenvalues and eigenvectors of matrices, and the topic for the following meeting be further study of differential equations.

Green(HO) moved that these recommendations by the Mathematics Committee be accepted. The motion was seconded and unanimously passed.

b. Program Development Committee.

This committee recommended that:

1) A standard double precision floating point number shall occupy two consecutive storage cells. The first cell shall contain a sign bit, an eight bit biased characteristic, and the 27 most significant bits of the mantissa; the second cell shall contain the 36 least significant bits of the mantissa.

2) Complex numbers shall occupy consecutive storage cells, the real part preceding the imaginary part.

3) The USE Compiler shall be expanded to include an additional class of instruction-type lines of coding to facilitate the use of the IP (14) instruction. These will be identified by the occurrence in the OP Field of certain symbols which are different from all other compiler language operations and from the names of all subroutines. Each of these new operations will be translated into IP (14) instructions. The v-address field will be translated as in ordinary instructions. The u-address field will be translated in the ordinary way and then taken module 2^9. A warning will be given if $(u) \neq (u) \bmod 2^9$. Finally a six, bit code corresponding to the particular operation used will be placed in the high-order part of u.

4) All interpretive routines shall be standard USE subroutines with no parameters or arguments required. The method of activation shall be as described in the 10 April letter by Perkins(RW), from which recommendations (1) and (3) are taken.

5) The catalog of programs submitted through USE be of the lexicographical type recommended by the subcommittee.

6) The prime responsibility for informing USE of errors in a USE program rests with the organization originating the program in question. That organization will immediately write a letter to the Executive Secretary informing him that an error has been found and briefly describing the nature and effect of the error in a program. As soon as possible, that organization will supply corrected duplicatable sheets to replace the incorrect sheets of the previous writeup. The date of the most recent correction must appear on the cover sheet; this date may be put in by the Executive Secretary or a new cover sheet may be supplied by the originating organization. The Executive Secretary will then produce copies of the complete write-up as corrected, for normal USE distribution. No delays at any phase of this revision process are acceptable.

Recommendation (5) concerning the catalog of programs was deferred for further discussion by the Policy Committee at the next meeting.

The other recommendations of the Program Development Committee were accepted by the Policy Committee.

c) Installation Operations Committee

The Installation Operations Committee recommended that:

1) Each installation should keep a log of frequency and type of malfunctions of the Bull Reproducer and make this information available to the committee.

2) That a subcommittee with representatives from AP, CE, BC, RR and OR (with George Clark, OR, as chairman) study the feasibility of a standard acceptance test and report back at the next meeting.

3) That Remington Rand be requested to provide information at the next meeting on:

i) price of improved uniservos for the 1103A,

ii) double size drum,

iii) application of the File Computer to 1103A operation.

These recommendations were accepted by the Policy Committee.

Item 11. The Chairman read a letter from Ted Hellwig (RR) informing USE that Remington Rand was giving an additional 20 hours free time to the organization, bringing the total amount of free time up to 60 hours. This 20 hours was allotted to debugging the USE compiler. The Policy Committee expressed its gratitude for this additional time.

Item 12. It was suggested that the Mathematics Committee should be reminded to consider only topics which have some hearing on the 1103A and to use normal USE channels of distribution.

Item 13. Cook(BA) moved that the next USE meeting be held at Seattle on 24-26 July 1957. The motion was seconded and unanimously approved.

Item 14. Kennedy(RR) gave a report on the status of the Programming Manual. He suggested that a rough draft be submitted to USE members for editing and return by a specified date. The Committee agreed to this and further decided to have the status report repeated in the General Session.

Item 15. The Policy Committee expressed its appreciation to Remington Rand for undertaking to provide certain of the previously requested machine modifications without charge, namely:

a) change of Uniservo "not ready" condition from a B-fault to an IO lockout,

b) avoidance of necessity for master clear before changing a tape rewound with interlock,

c) immediate detection of card and tape faults to facilitate program recovery.

The Policy Committee was in session from 9:30 to 4:30 (excluding lunchtime) on 24 April and from 1:00 to 3:30 on 25 April.

Respectfully submitted,

R P Rich

R. P. Rich
Chairman

RPR:lbg

Talmadge

USE COMMITTEE REPORT
INSTALLATION OPERATIONS COMMITTEE MEETING
25, 26 APRIL 1957

The Installation Operations Committee met on the afternoon of 25 April and the morning of 26 April 1957.

The following agenda was given to this committee by the Policy Committee:

1. 1103A operating experience to date.
2. Availability and use of the drum "dead space."
3. Action regarding the performance of the Bull reproducer.
4. Status reports on machine modifications.
5. The elimination of the master clear operation in order to remove tapes from the Uniservos.
6. The establishment of acceptance tests and performance standards.
7. The 1103A buffered input-output system.
8. Plastic tapes and improved servos.
9. Spare parts availability.

In addition, the committee chose to add the following three items to its agenda:

1. The establishment of a check list for reporting operating experience.
2. Description of a computer timing reference chart developed at Lockheed.
3. Clock initiated interrupt.

The following is a summary of the discussions of experience to date. Don Cook (BA) reported that the Boeing Compiler was approximately 90% checked out. Considerable difficulty was experienced in reading binary cards and plans now include an octal card output from the compiler. The faulty bad spot detection circuits had not been corrected at the time of the meeting necessitating the use of unpunched magnetic tape. Bernie Dove (ML) stated that Lockheed is now operating on a 2-shift basis. The computer was run for 72 hours without any maintenance whatsoever. Due to the lack of a verifying system they are ignoring Unityper errors in coding leaving them for the programmer to find during debugging. Garner McCrossen (HO) said Holloman's machine required approximately 2 weeks to install and they had had the system for about 5 weeks. A logical error discovered in the card handling equipment was corrected by their engineers and now appears to be functioning satisfactorily. John Spencer (CE) reported that their computer has not been accepted as yet. An attempt was being made to check out the corrected bad spot detection circuits on the Uniservos. Bob Rich (AP) said that their computer arrived on 12 April and they expected to take delivery momentarily. Don Gantner (RW) asserted that their machine was expected to arrive on Friday, April 26 and that power is expected to be turned on the following Monday.

Regarding the availability of the drum "dead space", it appeared that only one member anticipated difficulty in negotiating with the customer engineers for space for service routines. It was pointed out that it is the customers prerogative to select the interlace to be used. The engineers have one service routine which must be run using a 16 word interlace. If this does not concur with the choice of interlace used at a particular installation the engineers should be required to change interlace for the running of that routine. In any case negotiation with the engineers for space on the drum should be carried out on an individual basis. If the result of such negotiations are not satisfactory to the customer they may be taken up with the local sales representatives.

The opinion was unaninously expressed by users of Remington Rand equipment present at the meeting that the Bull reproducer was an unsatisfactory piece of equipment as delivered. However, it was reported by several installations that, as experience was gained with this equipment, the engineers were able to make minor adjustments which deviated from the recommended settings but led to satisfactory performance. Lee Dominic (RR) pointed out that just complaining about the card equipment does not give Remington Rand enough information to correct the situation. It must at least be known what kind of failure is occurring. In light of the foregoing remarks, it was agreed that the members would keep an accurate log on the performance of the Bull to be presented at the next meeting. At that time further action can be initiated if such appears to be necessary. No further action was recommended at this time.

During the discussion of a standard acceptance test, it was pointed out that such a test is not static but is apt to vary from one installation to another depending on the particular requirement of the installation. Don Heiser (BC) ventured the opinion that the best acceptance tests are the production type programs developed at a particular installation. A number of others concurred in this opinion. However, it appeared desirable to study this matter at greater length. A subcommittee was appointed to make a feasibility study and report back at the next meeting. This subcommittee consisted of a representative from the Applied Physics Lab, Corps of Engineers, Bureau of the Census, Remington Rand and the Operations Research Office with George Clark (OR) acting as chairman.

Bob Schmidt (RR) announced the availability of a buffered input-output system for the 1103A and described the major features of the system in some detail. Complete information concerning the system is to be made available thru the local representatives.

Dick Todd (Eglin AFB) and Don Heiser (BC) described their experiences with plastic tape on the Uniservos. In particular the Uniservos at the Bureau of the Census have been modified slightly to permit the complete interchangeability of plastic and metallic tapes. No information was available at this time regarding the improved Uniservos. Remington Rand agreed to present information regarding the use of plastic tape and the improved Uniservos at the next meeting.

The question was raised as to the adequacy of the Spare Parts Kit. Lee Dominic (RR) mentioned that the contents of this kit are defined on the basis of the performance records of equipment in the field and is always subject to review. The Spare Parts Kit now available thru Remington Rand is still their best recommendation. It was suggested that a review of the contents of this kit may be in order and should be carried out on an individual basis.

As suggested by Bernie Dove (ML) an attempt was made to define a check list for reporting operating experience. The most desirable bit of information, it appeared, is a number which describes the machine performance. Lee Dominic (RR) described the system used by the engineers to determine performance ratios. Because of the lack of time this subject was referred to the subcommittee on feasibility of an acceptance test for further consideration.

Bob Schmidt (RR) informed the committee that Remington Rand would like USE to accept all or part of the machine modifications as a package. This package would then be priced on the basis of becoming standard equipment on all 1103A's. Prices were quoted on each modification and on all modifications as a package. He pointed out that the Uniservo Indicator Lights and the Computer Stop Bell are external modifications which can be made readily whereas the modified Overflow Stop, Abnormal to Normal Drum Instruction and Address Interchange Instructions involve alterations in the computer logic. Remington Rand might be willing to price the former on an individual basis. It now remains for USE to make a counter-proposal regarding these modifications to Remington Rand. It was agreed that the individual members would consider the practicality of the modifications and come to the next meeting prepared to frame such a proposal.

Jack Potter (ML) described a computer timing reference chart which he developed. Setting an arrow on an indicator disc to a desired input-output function disclosed, thru a pair of windows in the disc, the proper EF bits to accomplish this function and the necessary timing information. Negotiations are now under way with Remington Rand to make this chart available to 1103A users.

A clock initiated interrupt suggested by Donn Combellic (RW) was discussed. This feature consisted of a set of switches to run the clock forward or backward or turn it off plus the ability of the clock to initiate an interrupt on a zero reading. One application of such a feature would be useful in debugging. However, due to an apparent lack of interest this subject was not pursued further.

The following items are to be discussed further at the next meeting and are to appear on the agenda for that meeting:

1. Holloman AFB computing system.
2. Action of Bull Reproducer.
3. Standard confidence test.
4. Check list for reporting performance.
5. Plastic tape and improved servos.
6. Acceptability of machine modifications.

Respectfully submitted,

Donald I. Cook

Donald I. Cook, Chairman

Talmadge

5 June 1957

All USE Members:

Arrangements have been made for the next USE Meeting to be held in the Ben Franklin Hotel at Seattle, Washington on July 24, 25 and 26.

Policy Committee Members should plan to arrive the night of July 23 while the remainder of the members of your organization planning to attend this meeting should arrive the night of July 24.

Please submit to me the names of all of your members planning to attend this meeting so the proper hotel accommodations can be made.

If you plan to invite any guests, please submit their names and affiliations to me as well.

There will be some over-flow into the Hotel Roosevelt. It would be appreciated if this information were sent to me in the near future.

Very truly yours,

W. E. McVicar

W. E. McVicar
Executive Secretary, USE
Remington Rand Univac
Univac Park
St. Paul 16, Minnesota

WEM:lps

Talmady

USE ORGANIZATION MEETING

April 25 and 26, 1957
Van Cleve Hotel, Dayton, Ohio

Report of the Program Development Committee

The Program Development Committee met Thursday afternoon, April 25, and Friday morning, and for one hour Friday afternoon, April 26. Appendix A lists the presons attending one or more of these meetings.

Agenda

The Policy Committee recommended the following items for the agenda of the Program Development Committee:

1. Catalog of USE Subroutines,
2. Method of Revision of USE Subroutines,
3. Collect and formalize standards for coding and writeup,
4. Recommend action on Burlingames' programmed program interrupt,
5. Progress report;
    a) USE Compiler
    b) Generalized Print Edit Routine
    c) Coding assignments
6. Double Precision Floating Point
7. Use of IP instruction
8. Card Output routine for Compiler

The committee chairman added to this agenda the following items:

1. Discussion of Boeing's Drum Dead Space Service Routines
2. General Discussion of operating experience with the 1103A and of operating systems.
3. Discussion of possible revision of requirements of standard USE Subroutines.

The items in the agenda were not necessarily considered in the sequence listed above. The remainder of this report covers the items in the sequence in which they were brought up in the committee.

Progress Report on Generalized Print Edit Routine

Wright Field submitted a progress report along with a writeup of a slightly revised specification of the Generalized Print Edit Routine. This report has already been distributed as Appendix B by the USE Executive Secretary.

The Edit Routine has been coded and is available on symbolic cards and is ready for assembly. Some preliminary checking has been on the Wright Field 1103. An octal number conversion routine suitable for use with this Editing Routine has also been coded and is available on cards for assembly. The cards will be taken by Ramo-Wooldridge and assembled using the USE Compiler. Ramo-Wooldridge will attempt to complete a successful assembly by eliminating any errors found by the Compiler. When this has been completed, the side-by-side listing will be sent to Wright Field along with the corrected symbolic cards and Wright Field will undertake to complete the machine checkout. This checkout will be completed by the time of the next USE Meeting.

Progress Report on USE Compiler

The USE Compiler is being used successfully by Ramo-Wooldridge on the Palo Alto 1103A computer and by the Corp of Engineers on their machine. At this time all known errors have been corrected in the Compiler and certain modifications are being added to it. The most recent modifications have not yet been checked out due to unavailability of 1103A time. It is expected that by approximately May 15, an up-to-date version of the USE Compiler will be available in the form of a self-loading binary deck. This deck may be obtained from Ramo-Wooldridge after that time by writing to them.

Although a Subroutine Library is not part of the USE Compiler, one will be made available. A list of standard USE Subroutines which have been checked out and are now available on symbolic cards is attached as Appendix C of this report. The routine associated with the USE Compiler which incorporates standard USE Subroutines so that they can be used for magnetic tape by the USE Compiler is being checked out at the present time. It is expected that this routine will be successfully completed by approximately the middle of May.

As stated above, there are now 26 standard USE Subroutines available on symbolic cards. It has been previously agreed that the normal method of transmitting USE Subroutines is in manuscript form, however, it has been agreed that other methods of transmission of subroutines may take place on an installation to installation basis rather than through the Executive Secretary of USE. Ramo-Wooldridge agreed to make available to any interested installation the standard USE Subroutines on symbolic cards upon written request to them.

It was brought out that each installation should have available to it a table showing the correspondence of the Uniservo pulse codes and the punch code combinations on IBM cards. Ramo-Wooldridge agreed to provide each installation with such a table at an early date.

There was a discussion of the use of cards as input to the USE Compiler. Some installations find that the keypunch people strongly resist a pure serial type of input which is possible on cards with the USE Compiler. They have asked that Ramo-Wooldridge investigate the possibility of using an identification by column on cards which are used as input to the USE Compiler. It was pointed out that this would probably greatly speed the compiling process using card input for the program to be compiled. Combelic (RW) pointed out that they are probably going to use condensed card input for compiling of a program the first time it is put on the machine. After that the program to be compiled will be available in side-by-side listing form on magnetic tape and this form could be the original input for all subsequent compilations thereby speeding the compiling process.

There was a brief discussion about some of the details of the USE Compiler. It was brought out that item numbers may not be used in subroutines, neither in item number column nor in the u or v addresses of lines of coding. If item numbers appear in the item number column, of subroutines available on symbolic cards, this will not interfere with their being incorporated into the magnetic tape subroutine library by the special program mentioned above. This program strips off the item numbers so that they do not appear on the magnetic tape in the subroutine library. However, item numbers may not appear in the u or v addresses of lines of coding in any case. The question was asked about the speed of compiling subroutines relative to the speed of compiling other programs. It was brought out that subroutines do compile somewhat faster on the basis of the amount of time for each line of coding but a quantitative figure is not known--it is probably somewhere between 10 and 20 percent faster.

Double Precision Floating Point Numbers

After some discussion it was agreed to make the following recommendation to the Policy Committee on the subject of double precision floating point number format and as a subsidiary point, an explicit statement of the form of complex numbers.

Recommendation:

1. A double precision floating point number in standard packed form shall occupy two consecutive cells. The first cell shall contain a standard single precision floating point number consisting of a sign bit, an 8-bit biased exponent, and the 27 most significant bits of the mantissa. The second cell shall contain 36 additional bits of the mantissa. Examples of such numbers are:

	Dec. No.	1st Cell Octal	2nd Cell Octal
1)	+ 2.5	202 500 000 000	000 000 000 000
2)	+ .125	176 400 000 000	000 000 000 000
3)	- .125	601 377 777 777	777 777 777 777

2. A complex number shall occupy consecutive cells in the machine; the real part shall be followed by the imaginary part of the complex number.

Inasmuch as the preceding recommendation was accepted by the Policy Committee this form of double precision floating point numbers and of complex numbers will be standard in the USE Organization.

Use of IP Instruction

There was a general discussion of interpretive routines at this time. The discussion revolved around three main points.

1. Format of an interpretive instruction as a line of coding and as a word in the machine.

2. Method of activation of an interpretive routine.

3. The mnemonic abbreviations for instructions which are to be interpreted.

The discussion and recommendations on these points took place at different times throughout the meetings of the Program Development Committee, however, they will be grouped here in this report.

On point number 1 the following recommendation was made to the Policy Committee:

Recommendation:

> The USE Compiler language shall be expanded to include an additional class of instruction type lines to facilitate the use of the IP instruction. These will be identified by occurrence in the OP field of certain symbols which are different than other compiler language operations and from the names of all subroutines. Each of these new operations will be translated into 14 (Interpret) operations. The v-address field will be translated as an ordinary instruction. The u-address field will be translated in the ordinary way and then taken modulo 2^9. A warning will be given if u is not equal to u mod 2^9. Finally a 6 bit code corresponding to the particular operation used will be placed in the high order part of u.

Inasmuch as this recommendation was accepted by the Policy Committee, the preceding paragraph describes the standard form of instructions to be interpreted which is to be used by the USE Organization.

Method of Activation of Interpretive Routines - After some discussion, the following recommendation was made to the Policy Committee:

Recommendation:

> All interpretive routines shall be standard USE Subroutines. They shall be standard USE Subroutines with no arguments or parameters. They shall be called for by writing a line of coding wherein the operation field is the standard name of the interpretive routine. The u field of such a line of coding would invariably be left blank, the v field would be filled in as with any standard USE Subroutine calling sequence line of coding. The compiler would replace this line of coding with a single return jump to the standard entry of the called for subroutine. This would result in cell 1 in the machine being set up with a manual jump instruction to the appropriate cell within the interpretive routine. Subsequent instructions with 14 (interpret) operation codes would then in effect transfer control to the appropriate cell within the most recently activated interpretive routine. Symbolically such a standard USE interpretive subroutine might begin as follows:

ITEM NUMBER	TAG	OPERATION	U ADDRESS	V ADDRESS	COMMENTS	
,	,	SUB ,	MATRIX ,	n	, FIRST THREE	$
,	,	INOUT ,	0 ,	r	, LINES USED BY	$
,	,	TEMPS ,	t ,	0	, COMPILER.	$
,	ENTER ,	MJ ,	0 ,	SETUP	, ENTER HERE VIA	$
,	ERROR ,	ALARM ,	0 ,	0	, CALLING SEQUENCE	$
,	EXIT ,	MJ ,	0 ,	FILL	, TO ACTIVATE	$
,	RESULT ,	RESERV ,	r ,	r	, PSEUDO ACCUM, ETC.	$
,	SETUP ,	TP ,	DUMMY ,	1	, SET UP JUMP	$
,	,	MJ ,	0 ,	EXIT	, IN CELL F2.	$
,	DUMMY ,	MJ ,	0 ,	INTERP	, JUMP FOR F2.	$
,	INTERP ,	,	,		, ENTER HERE VIA	$
,	,	,	,		, F2 TO INTERPRET	$

The cells reserved for "RESULTS" could be the pseudo accumulator, B-boxes, or whatever else would be useful in case of an alarm exit. This scheme permits the inclusion of two or more interpretive subroutines in the same program.

Inasmuch as this recommendation was accepted by the Policy Committee, the procedures outlined above for interpretive routines will henceforth be standard in the USE Organization.

Interpretive Mnemonic OP Codes

Ramo-Wooldridge and Lockheed Missiles were appointed as a sub-committee to make detailed recommendations with respect to mnemonic OP codes for instructions which are to be interpreted along with the octal equivalent of such instructions as well as their definitions. The sub-committee is instructed to make recommendations to be distributed to all member organizations. The purpose of this is to allow a final set of standards on this matter to be finally agreed upon at the next USE Meeting.

Burlingame's Programmed Program Interrupt

Mr. Burlingame is an 1103A engineer working with the Corps of Engineers. The Corps of Engineers will incorporate into their machine an addition to the program interrupt feature along the following lines. There will be available some instruction which may be an EF instruction with a unique EF code which will allow an interrupt pulse to be initiated under program control. Associated with the initiation of this sequence will be a delay counter which will allow execution of a certain number of instructions immediately after execution of the EF instruction; after this fixed number of instructions has been executed, an interrupt pulse will be sent out. One programming use of this procedure would be to allow tracing of a program. Richard Petonke of the Corps of Engineers described this feature. After some discussion it was agreed that the Program Development Committee could not at this time have an effective discussion because of lack of knowledge of details. Petonke agreed to gather together all the information that the Corp of Engineers has available on the details of this feature along with any recommendations from their organization about the use of such a feature and incorporate them into a USEful Note which would then be circulated to all USE members. It was agreed that this USEful Note should be circulated well in advance of the next meeting of USE in order for the individual members to be in a position for an effective discussion of the use of this feature at the time of the next meeting. It was not felt appropriate at this time to make a formal request from Remington-Rand on the price of such a modification. The Corps of Engineers will, if possible, include any information about their experience, along with the estimated cost of the modification in the USEful Note.

Catalog of USE Routines

At the last Program Development Committee meeting in January, a sub-committee consisting of members of APL and ORO was appointed to make recommendations with respect to a catalog classification system for USE Routines. At that meeting two very different methods had been proposed and discussed, namely a catagorical scheme and a lexicographical scheme. After considerable discussion of the merits and disadvantages of each of the schemes, a vote on a recommendation to the Policy Committee was taken. The vote was 6 to 4 in favor of recommending the lexicographical scheme to the Policy Committee for acceptance as a standard USE Cataloging method. The following organizations voted in favor of the lexicographical scheme: ORO, BA, HO, RR, RW, AP. The following organizations voted for the categorical scheme: Bureau of Census, WF, CE, ML. The report of the sub-committee appointed at the January meeting is attached as Appendix D of this report in the form of a letter from its chairman to the chairman of the Program Development Committee. A suggestion for a catagorical scheme was submitted by Lockheed at the January meeting and is a modification of the SHARE system. This suggested catalog classification is attached as Appendix E of this report. Inasmuch as a recommendation to the Policy Committee to accept the lexicographical scheme was not accepted, it is believed appropriate to attach these detailed descriptions of the two schemes so that final action may definitely be taken at the next USE Meeting. In the catagorical scheme, a proposal for which is attached as Appendix E, the letters outlining the main classes of routines and the numbers indicating the sub-classes would be incorporated as a letter number pair in the name of each standard USE Subroutine. In the lexicographical scheme, the only requirement would be that the first two letters be those officially assigned to the originating installation.

Collection of Formalization of Standards for Coding and Writeup of USE Programs

After some discussion it was agreed that the most effective way of achieving this up-dating and formalization of the indicated standards was to have Ramo-Wooldridge produce an expanded up-to-date USE Compiler Programming Manual, and incorporate therein a complete description of the exact format of the USE Subroutine programs and the writeup thereof. It was pointed out by Robert Tantzen of Holloman that since the Transuse language could be understood by the USE Compiler, it might be well to incorporate into the suggested writeup a statement to this effect and pointing out in some detail those features of the USE Compiler which were not features of the Transuse Conversion Program. It was agreed that RW and HO would work together on deciding the advisability and feasibility of including this feature in the suggested writeup. The Compiler Programming Manual No. 2 alluded above is to be ready for distribution to all members of the USE Organization before the time of the next USE Meeting.

Method of Revision of USE Routines

After some discussion it was agreed unanimously to make the following recommendation to the Policy Committee on the matter of revising, correcting, and updating writeups and programs submitted through the Standard USE channels.

Recommendation:

The responsibility for correcting, revising, modifying, up-dating, etc., of any routine submitted to the USE Organization shall rest with the member organization originating the routine.

As soon as the originating organization is made aware that there is an error, in either the writeup or the coding of a routine which they have submitted to the USE Organization, they shall immediately write a letter to the Executive Secretary of USE. The first paragraph of this letter shall state "An error has been found in routine ____________________". The remainder of the letter shall state what action has been taken or is being taken to correct the routine and the writeups which have been submitted, the effect of the discovered error on programs which have used this routine, and the nature of the error. This letter shall be forwarded immediately to the Executive Secretary of USE who shall duplicate it without delay and will send it on to all the member organizations.

The originating installation shall as soon as practicable send to the Executive Secretary of USE the corrected sheets which are to replace the erroneous sheets in the previous report so that the Executive Secretary, by properly combining the original and the new sheet, may produce a completely correct, up-to-date program writeup. Each such sheet submitted shall have written in the upper righthand corner "Corrected" followed by the date of the effective correction. The Executive Secretary shall make sure that the cover sheet of the subroutine writeup bears the same notation before the corrected and complete writeup is circulated to the USE Members.

The USE program shall not have its identifying abbreviated name changed merely because the previous edition has been corrected. A routine shall have its identifying name changed only when it is a revision or modification of a previous routine which is correct.

The above recommendation was accepted by the Policy Committee and is therefore a standard procedure to be used in revising USE Routines submitted through the USE Executive Secretary.

Coding Assignments

Included in coding assignments is the disposition of item 8 of the formal agenda namely "Card Output Routine for USE Compiler".

Robert Tantzen (HO) has volunteered to prepare as a standard USE Subroutine a program which will translate the side-by-side listing of a program compiled by the USE Compiler to punched cards in a form suitable for listing. In this connection, it was pointed out that the side-by-side output listing format produced by the USE Compiler has been modified from that previously used so that the execution and storage addresses followed by the octal equivalent of the word appears on the leftmost part of the printed page. This information is immediately followed by the symbolic form of the line of coding in question and this line of coding ends with the comments. It was agreed that this tape-to-card routine would do no more than take the first 80 excess 3 characters from each blockette on a side-by-side listing tape and translate on a 1 for 1 basis to the standard punch card combinations to produce the listings. It was pointed out that in some cases this might result in truncating the comments. It was agreed that the excess 3 pulse code equivalents and that the punch combinations on the IBM card both be supplied in tabular form so that a simple change of 1 or both of these tables would allow the routine to be modified so that both its input and output would be compatible with the characteristics of the High-Speed Printer and/or the IBM Listing equipment used at that particular installation. The writeup of the routine is to make it perfectly clear exactly how this may be done whenever desired. R-W and HO will coordinate the activity on this routine so that it will meet completely the preliminary specifications described above.

Some coding assignments were made for number conversion programs to be associated with the Generalized Edit Routine being worked on by Wright Field. They have already coded a binary to octal number conversion program--this was mentioned earlier in the report. They also have available an alphanumeric conversion program which consists of nothing more than moving excess 3 characters around in the proper manner.

Wright Field has agreed to code a stated decimal single precision and a floating decimal single precision number conversion subroutine for use with the High-Speed Printer Generalized Edit Routine. These two routines will be coded as standard USE Subroutines and will be completely checked out and made available to all members at the time of the next USE Meeting.

Wright Field has also agreed to start work on a number conversion program suitable for use with the Generalized Edit Routine which will convert double precision floating point binary numbers to excess 3. They will attempt to have this routine done by the time of the next USE Meeting, but are not able at this time to say definitely that it will be done.

No other coding assignments were made except those implied in the discussion of progress on the USE Compiler.

Revision of Standards for Subroutines

The present standards for a USE Subroutine require that control be transferred back to the main program from the subroutine to the cell immediately following the return jump to the subroutine. It was pointed out that this precluded the acceptance as standard USE Subroutines of many programs which now make use of the cells immediately following the calling sequence to contain parameter words. In such cases the parameters are immediately transferred into the subroutine in accordance with the USE Standards but control returns to the cell immediately following the last of these parameter words. After some discussion it was agreed that the present standards are workable and it did not seem worthwhile to reopen the subject again. Therefore, the present standards for USE Subroutines remain in effect. As mentioned previously, they will be incorporated as part of the USE Compiler Programming Manual No. 2.

Boeing Service Routine Package

Richard Carriker of Boeing submitted to the committee a writeup of the Boeing Service Routine package which is contained on the magnetic drum dead space of the Boeing 1103A. The writeup was submitted on vellum masters and will be made available to the entire organization in the form of a USEful Note. The presentation of this report precipitated a discussion on operating systems and behaviour of 1103A's in general. It was pointed out by Philip Desilets of Remington Rand that each group of the drum has available not less than 128 cells in the drum space, yielding a total of 512 drum dead space cells in all. However, it was noted that in no case did any drum have less than 150 cells in the dead space in each group and could have as many as 170. It was pretty generally agreed in fact that each organization could assume not less than 160 dead space cells per group even though Remington Rand guaranteed only 128. The problem of having the dead space programs operate with more than 1 interlace was discussed and it was pointed out that Boeing's service routines would operate only with 4 interlace. It appeared from the discussion that this would be adequate to handle virtually all cases and that other less convenient methods would have to be used when programs required other than 4 interlace. The discussion continued about some details of tape operation, and so forth.

Modifications of USE Compiler for Machines Without Built-in Floating Point

Robert Tantzen of HO pointed out that some installations are not now getting the built in floating point with the 1103A but do expect to at some later time. It was also mentioned that in particular the exchange and writing of mathematical routines by installations which did have built-in floating-point might be somewhat inhibited because the standard USE Machine did not have built in floating point. It was recommended that the USE Compiler be made available in a 2nd version to facilitate the handling of this problem. The modification would work something like this. The 9 operation codes associated with the built-in floating point package would be treated as lines of coding calling for a standard USE subroutine. For example, an FM operation code would be translated by the USE Compiler to a return jump to a compiled subroutine. This compiled subroutine would simulate completely and in detail the actual operation of the built-in floating point multiply instruction leaving all registers associated with the execution of this instruction in exactly the same state as they would be if the floating multiply had actually been executed by the floating point package. A set of such subroutines would be developed and made available as part of the USE Compiler

Subroutine Library. It was agreed that this modification to the USE Compiler would greatly enhance its value. Tantzen of HO pointed out that they have already solved the problem at Holloman by causing the Transuse Conversion Program upon encountering a floating point operation to incorporate at that point in the coding a sufficient number of lines of coding to simulate the built in floating point operation. This technique could be described as incorporating open-ended subroutines into the main program. The modification of the USE Compiler described would essentially incorporate, usually into the compiled region, a set of closed subroutines for simulating the floating point operation. HO will write up this feature of the Transuse Conversion Program and make this report available to the USE members as a USEful Note. The modification to the USE Compiler will be undertaken as soon as possible and the specifications will be included in the USE Compiler Programming Manual No. 2 by R-W.

Conclusion

The Program Development Committee will next meet on July 25 and 26 at Seattle in conjunction with the meeting of the entire USE Organization, Boeing acting as hosts for the meeting.

Respecfully submitted,

Donn Combelic

Donn Combelic, Chairman
Program Development Committee

APPENDIX A

Jim Atwood	Wright Field
Frederick W. Bauer	Wright Field
K. W. Bauman	WPAF
Roy V. Bigelow	White Sands Proving Ground
Richard W. Carriker	Boeing Airplane Company
Donn Combelic	Ramo-Wooldridge
Philip H. Desilets	Remington Rand
Thomas Dewey	Lockheed Missiles
George Etsell	Remington Rand
Leonard B. Fall	Wright Field
Lucille Graham	White Sands Proving Ground
Ralph S. Graham	Wright Field
Leo B. Kennedy	Remington Rand
Ben Mittman	Remington Rand
H. E. Peterson	WPAF
Richard H. Petonke	Corps of Engineers
G. L. Pyle	White Sands Proving Ground
Robert Rich	Applied Physics Laboratory
Norman Schneidewind	Remington Rand
B. T. Shafer	Bureau of Standards
Alexander G. Stone	Applied Physics Laboratory
Richard Talmadge	Lockheed Missiles
Robert G. Tantzen	Holloman
W. B. Taylor	Operations Research Office
Arla Weinert	Operations Research Office

APPENDIX C

Standard USE Subroutines Available on Symbolic Cards

April 23, 1957

RWEXX2	Stated	Point	Exponential
RWLNX1	"	"	Natural Logarithm
RWATX0	"	"	Arctangent
RWSCX1	"	"	Sine and Cosine
RWSNX1	"	"	Sine
RWCNX1	"	"	Cosine
RWSCX2	"	"	Sine and Cosine, small angle
RWSNX2	"	"	Sine, small angle
RWCNX2	"	"	Cosine, small angle
RWASX1	"	"	Arcsine and Arcosine
RWASX3	"	"	Arcsine
RWACX3	"	"	Arcosine
RWSQX0	"	"	Square Root

RWSQF1	Floating	Point	Square Root
RWEXF3	"	"	Exponential
RWLNF2	"	"	Natural Logarithm
RWATF1	"	"	Arctangent
RWSCF4	"	"	Sine and Cosine
RWSNF4	"	"	Sine
RWCNF4	"	"	Cosine
RWASF2	"	"	Arcsine and Arcosine

RWDIX1	Stated Point Definite Integral
RWRNX0	Stated Point Random Numbers
MLT001	Octal Tape Read
RWCPX2	Stated Point Card Output
RWGMX3	Stated Point Gill Method Integration

APPENDIX D

..........The advantages and disadvantages of both schemes were discussed. In both schemes the detailed description and coding of the routines would be filed in order by the tag. In the four alpha-numeric digits of the tag, the collating sequence would be numeric followed by alphabetic. The advantages attributed to the classification scheme were:

a. the tag would describe the routine and therefore one would not require an index if the classification scheme were known,

b. the detailed description and coding of like routines would be filed together.

The disadvantages attributed to the classification scheme were:

a. the difficulty of determining the category into which a particular routine belonged,

b. the difficulty of designing an all inclusive classification system.

The advantages attributed to the lexicographical scheme were:

a. the ease of placing the titles of the routines in the index since no decision is required as to classification,

b. cross referencing could be accomplished by writing the title of the routine in various ways,

c. an installation may still design its own classification scheme for the tags.

The disadvantages attributed to the lexicographical scheme were:

a. the index must be referred to in order to find the tag of a routine,

b. the detailed description and coding of like routines would not be filed together.

After the discussion of both schemes, the subcommittee agreed that the lexicographical scheme was more desirable. A sample listing using this scheme was prepared and is enclosed with this report.

The subcommittee makes the following recommendations:

a. the USE organization adopt the lexicographical scheme of cataloguing,

b. each installation forward to the executive secretary the description, coding, tag and short title of the routine,

c. the USE organization accept the offer of APL to maintain the catalogue,

d. the USE organization request that RemRand, St. Paul reproduce and distribute the periodic listing produced by APL.

* 1 indicates USE routine, 2 indicates non-USE routine

Square Root - Floating Point	RR5671	1
Square Root - Stated Point	RR5670	1
Stated Point Data Tape Output	BATPSP	1
Tape Acceptance Test	MLTP1	2
Tape Handler - General	RRTAPE	1
Tape Input - Floating Point	MLTP1	1
Tape Input - Octal	MLTP2	1
Tape Output - Stated Point	BATPSP	1
Trace - Jump	RRTR10	1
Transuse	HOTRAN	1

APPENDIX E

SUGGESTED CATALOG CLASSIFICATION FOR USE ROUTINES

A. Programmed Arithmetic

1. Real
2. Complex
3. Decimal

B. Elementary Functions

1. Trigonometric
2. Hyperbolic
3. Exponential and Logarithmic
4. Roots and Powers

C. Polynomials and Special Functions

1. Evaluation of Polynomials
2. Roots of Polynomials
3. Evaluation of Special Functions

D. Operations on Functions and Solutions of Differential Equations

1. Numerical Integration
2. Numerical Solutions of Ordinary Differential Equations
3. Numerical Solutions of Partial Differential Equations
4. Numerical Differentiation

E. Interpolation and Approximations

1. Table Look-up and Interpolation
2. Curve Fitting
3. Smoothing

F. Operations on Matrices, Vectors and Simultaneous Linear Equations

1. Matrix Operations
2. Eigenvalues and Eigenvectors
3. Determinants
4. Simultaneous Linear Equations

G. Statistical Analysis and Probability

1. Data Reduction
2. Correlation and Regression Analysis
3. Sequential Analysis
4. Analysis of Variance
5. Random Number Generators

H. Operations Research and Linear Programming

I. Input

1. Binary
2. Octal
3. Decimal
4. Composity

J. Output

1. Binary
2. Octal
3. Decimal
5. Analog
9. Composite

K. Executive Routine

1. Assembly
2. Compiling

L. Information Processing

1. Sorting
2. Conversion
3. Collating and Merging

M. Debugging Routines

1. Tracing
2. Dump
3. Search
4. Breakpoint Print

N. Simulation Programs

1. Peripheral Equipment Simulators

O. Diagnostic Programs

P. Service Programs

1. Clear, Reset Programs
2. Check Sum Programs
3. Restore, Rewind, Tape Mark, Load Button Programs

Z. All Others

Minutes of Program Development Committee
Appendix A

Talmadge

High Speed Printer Edit Routine

Wright Field Progress Report
19 April 1957

The High Speed Printer Edit Routine has been written and punched on cards in preparation for checking on an 1103A. Some preliminary checking has been done on the Wright Field 1103. In addition, an octal conversion routine has been written, punched on cards, and also partially checked on the Wright Field 1103.

Some modifications have been made in the specifications produced by the USE Subcommittee at Palo Alto in November 1956. No further modifications are anticipated. The following specifications for the off-line fixed block version are therefore expected to be final.

Edit Routine

The Edit Routine is a standard USE subroutine which edits alphanumeric information from core or drum memory, preparing magnetic tape suitable for listing on the off-line High Speed Printer. Any of a number of conversion or translation routines may be used to produce the alphanumeric characters for the Edit Routine from binary data.

The Edit Routine requires that one argument word be transferred into it by the calling sequence and that a parameter list be available. One entry into the Edit Routine is sufficient to produce any number of lines N, less than 1000, of identical format. Each column in the group of N lines requires two descriptive words in the parameter list.

The argument word which is transferred into the Edit Routine by the calling sequence is made up as follows:

```
X X  XX XXX  XXXXX
F E  T  N      P
```

P is the address of the first word of the parameter list.

N is the decimal number of lines of identical format to be produced. $(1 \leq N \leq 999)$

T is the decimal number of the servo unit on which output is to be recorded. $(1 \leq T \leq 10)$

E and F are octal digits which indicate that printer control characters are to be written as follows:

If F = 1,2,3, or 4, a fast feed 1,2,3, or 4 symbol is placed in the first of the N blockettes.

If $F_{32} = 1$, a multiline symbol is placed in each of the N blockettes.

If $F_{31} = 1$, a printer breakpoint symbol is placed in the first of the N blockettes.

If $F_{30} = 1$, a printer stop symbol is placed in the last of the N blockettes.

A block of information is written on tape as soon as it is complete.

A change in the specified servo unit will cause the Edit Routine to write a partially filled block if it exists before this change is accomplished.

When special symbols are to be written, the total number of characters available for blockette construction is 120 minus the number of symbols used.

The parameter list which is stored beginning at address P contains a pair of parameter words for each column followed by a pair of control words P_1 and P_2 to signal the end of the list. P_1 is always zero. If $P_2 = 0$, a partially filled block is not written at the end of N blockettes. If $P_2 \neq 0$, a partially filled block is written at the end of N blockettes.

Each pair of words in the parameter list is made up as follows:

```
XX  XXXXX  XXX XX
D     M     W   S

--  -----  XXXXX
             C
```

W is the decimal number of characters allotted to the column. $(1 \leq W \leq 120)$
S is the decimal number of spaces to precede the column. $(0 \leq S \leq 99)$
M is the address of the first word of data to appear in this column.
D is the octal increment to be added to M to obtain the addresses of data for succeeding lines of this column.
C is the first address occupied by the conversion routine which is required for data in this column.

The remainder of the second word of the pair may contain additional information required by the particular conversion routine, such as scaling, or the first address of additional information required. The precise form of this word will be specified by the particular conversion routine.

The Edit Routine generates a calling sequence which transfers this pair of parameter words into the particular conversion routine with the address C replaced by the address at which the conversion routine is to store W results.

Conversion Routines

Any number of conversion routines, which are also standard USE subroutines, may be available in the library. A "LOCATE" line in the program is used to select each conversion routine required and to assign a symbolic location, C, designated in the parameter list. Each conversion routine requires two argument words, which are transferred into it by the Edit Routine. These two arguments are the two words in the parameter list with C (i.e., the v address of the second word) replaced by the address at which the conversion routine is to store W results.

The results from the conversion routine will be a series of 6-bit excess three characters. On exit from the conversion routine Q_{35} will be zero if these characters are packed six to a word. Q_{35} will be one if these characters are stored one to a word in the rightmost six bits, with the leftmost thirty bits being zero.

Proceedings of the Mathematics Committee of the USE Organization

April 25-26, 1957 Dayton, Ohio

The Mathematics Committee met during the regular session of the USE organization at the Van Cleve Hotel, Dayton, Ohio under the chairmanship of Dr. James Ward, Holloman Air Force Base. The agenda for the session is given in Appendix A. Over 30 persons participated during the course of the meeting, representing 13 organizations. (See Appendix B.)

Thursday, April 25, 1957

Two papers were delivered at the morning session. One was a report by Harry Shaw of the Applied Physics Laboratory concerning a study of error growth using the Adams method for integrating ordinary differential equations (Appendix C). Werner L. Frank presented some results of an investigation into the methods of Runge-Kutta-Gill and Adams-Moulton as carried out by Dr. S. D. Conte at The Ramo-Wooldridge Corporation (Appendix D). Also a new method employing Gauss Quadrature was cited. Both of these talks generated considerable interest and discussion. Some very pertinent questions indicated further need for investigations in these directions. A number of other contributions were made in the discussion that followed, notably by R. Turner, G. Blanch, R. Simon and B. Rudin.

A brief summary of existing routines at the various installations is given in Appendix E.

In the afternoon Dr. Gertrude Blanch of Wright Air Development Center presented a paper devoted to some general considerations in choosing an integration procedure. In summary, she stated that:*

(1) Routines should incorporate special formulas for special cases.

(2) Each installation ought to have a 4th order Runge-Kutta routine.

(3) The Adams-Moulton method is noted for its stability as opposed to the more unstable method of Milne. However, the latter is probably good over a short interval, say $[0,1]$.

(4) The integral equation approach is recommended since it avoids predicting and may have better round-off control.

Dr. Blanch suggested a number of problems with which to test the various routines. (Appendix F.)

During the remainder of the afternoon a discussion took place which is summarized in the recommendations made to the Policy Committee. (Appendix G.)

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* These remarks are now available in a paper, "Criteria for the choice of an integration formula", and can be obtained by direct request to Dr. Blanch.

Friday, April 26, 1957

Dr. John Carr, University of Michigan and Wright Air Development Center, presented some error analysis techniques as applied to the Adams-Moulton and Runge-Kutta methods. He discussed general procedures which lead to error bounds for integration formulas. Dr. Carr noted that he was very much in favor of the discussions promoted by this committee and invited us to meet at some future time at the University of Michigan. Dr. Carr has consented to send to those present a number of reports dealing with the topic at hand and error analysis in general.

Prior to the general meeting in the afternoon, three status reports were presented to the group regarding programs prepared as a result of previous meetings:

(a) A preliminary description of the autocorrelation and spectral density routine was distributed by Harry Shaw (APL). The code is written but needs checking out pending acceptance of the 1103A. (Appendix H.)

(b) A description and symbolic USE listing was distributed by Werner L. Frank (RW) of a curve fitting program which employs orthogonal polynomials. (Appendix I)

(c) B. Rudin distributed an abstract describing a Lockheed routine for curve fitting by orthogonal polynomials. (Appendix J)

Submitted by

James Ward, Holloman

Werner L. Frank, The Ramo-Wooldridge Corp.

Appendix A

USE ORGANIZATION

AGENDA OF MEETINGS OF MATHEMATICS COMMITTEE

Host Organization: Wright Air Development Center

Dayton, Ohio

April 25-26, 1957

Theme: Ordinary Differential Equations

Chairman: Dr. James Ward, Holloman Air Force Base

Thursday, April 25, 1957

9:00 A.M. Experiments in Error Estimates in Solving Differential Equations

Mr. Harry Shaw, Applied Physics Laboratory

10:00 A.M. Experiments in the Numerical Solution of Differential Equations. A Comparison of the Methods of Runge-Kutta-Gill and the Predictor-Corrector Procedure of Adams Moulton

Mr. Werner L. Frank, The Ramo-Wooldridge Corporation

10:45 A.M. Discussion

12:00 Noon Lunch

1:30 P.M. Criteria for Choosing an Integration Formula

Dr. Gertrude Blanch, Wright Air Development Center

2:30 P.M. Discussion

3:30 P.M. Preparation of Report and Recommendations to USE Policy Committee

Friday, April 26, 1957

9:00 A.M. Generalized Functional Round-Off Error Analysis

Dr. John W. Carr III, University of Michigan and Consultant for Wright Air Development Center

10:30 A.M. Report by Members

a. Status of Curve Fitting Routine by Orthogonal Polynomials - Werner L. Frank

b. Status of Autocorrelation and Power Spectral Density Routine - Harry Shaw

12:00 Noon Lunch

1:30 P.M. General Session

Appendix B

Participants at Mathematics Committee

1.	Applied Physics Laboratory	Harry Shaw
2.	Frankford Arsenal	Ralph E. Brown
3.	Holloman Air Force Base	Garner McGrossen James Ward
4.	Lockheed Missiles	B. B. Rudin R. Talmadge
5.	National Advisory Committee for Aeronautics	George J. Moshos L. R. Turner
6.	Operations Research Office	Peter Pastoriza
7.	Radio Corporation of America (Waltham)	V. J. Harackiewicz
8.	Ramo-Wooldridge Corporation	Werner L. Frank
9.	Remington Rand	T. V. Cooper Ernest E. Haight Jack K. Hale Ben Mittman R. Simon Richard Zemlin
10.	White Sands Proving Grounds	Nancy Ingram Gray L. Pyle
11.	Wright Air Development Center (WCRRM)	D. S. Clemm H. E. Fettis M. Thomas M. Valentine
12.	Wright Air Development Center (WCRRU)	Thomas A. Brown Frances J. Cryan Miles S. Edwards Richard P. Harrison Harley Hill Sidney H. Miller Michael Tikson Hewitt S. Toney D. C. Zonars
13.	Wright Air Development Center (WCRRY)	Cheryle Smith Gertrude Blanch John W. Carr III (University of Michigan)

BCC-59

20 March 1957

TO: R. P. Rich

FROM: H. Shaw

SUBJ: Experimental Consideration of the Error Associated with Adams Method.

INTRODUCTION:

The use of numerical methods in approximating the solutions of initial value problems in ordinary differential equations is complicated by the fact that not a great deal is known about the way truncation and round-off errors are introduced at each step or about the way these stepwise errors accumulate as the solution proceeds. Such errors are evidently functions of the system of differential equations (and initial conditions), the numerical method, and the manner in which the arithmetic is carried out. An obvious way of attempting to learn something of the nature of these errors is experimentation in which these "parameters" are varied more or less systematically.

The choice of parameters should probably be made with the following basic classifications in mind. Differential equations are linear or non-linear. Arithmetic is fixed point or floating point with the number of figures retained being an additional variable. The usual numerical methods are of the open, closed, or Runge-Kutta types with the step size being an additional variable.

SUMMARY

A program was prepared for the IBM 650 in the Bell Interpretive System to solve the initial value problem consisting of the system of differential equations

$$1)\quad \begin{aligned} Y' &= Z \\ Z' &= -Y \end{aligned}$$

subject to the initial conditions

$$1')\quad \begin{aligned} Y(0) &= 0 \\ Z(0) &= 1 \end{aligned}$$

using Adams method with one difference

$$A1)\quad Y_{1,n+1} = Y_{1,n} + h\left(1 + \frac{1}{2}\nabla\right)Y'_{1,n}$$

$$Z_{1,n+1} = Z_{1,n} + h\left(1 + \frac{1}{2}\nabla\right)Z'_{1,n}$$

or using Adams method with two differences

$$A2)\quad Y_{2,n+1} = Y_{2,n} + h\left(1 + \frac{1}{2}\nabla + \frac{5}{12}\nabla^2\right)Y'_{2,n}$$

$$Z_{2,n+1} = Z_{2,n} + h\left(1 + \frac{1}{2}\nabla + \frac{5}{12}\nabla^2\right)Z'_{2,n}.$$

The differential equations are linear, both methods are of the open type, and the arithmetic is floating point retaining eight decimal digits.

The solution of problem 1-1' is Y= sin x, Z= cos x. Runs were made out to two cycles using A1 and A2 with 2^k steps per cycle k = 4(1)10 with the necessary number of starting values being provided to eight significant figures in each case. Values of the respective error functions.

$E_{j,h}(nh)= \sin nh - Y_{j,n}$, j= 1,2 were computed and punched out at intervals of one sixteenth of a cycle and the results graphed and included as Figures 2 - 9. A similar run but to ten cycles was made using A2 with a step size of one sixty-fourth of a cycle and the resulting error function graph is included as Figure 10.

The remainder of this memo consists of a discussion of the accumulated errors and stepwise errors observed in the above runs and of a comparison of errors for the two methods.

ACCUMULATED ERRORS

The error curves * indicate error functions of the forms

$$E_{1,h}(nh) \sim -C^2_{1,h} \cdot \frac{nh}{2\pi} \cdot \text{Cos } nh$$

$$E_{2,h}(nh) \sim C^2_{2,h} \cdot \frac{nh}{2\pi} \cdot \sin nh$$

where the C^2's correspond to errors accumulated over one cycle and are listed in Table I.

TABLE I

STEPS /~	$C^2_{1,h}$	$C^2_{2,h}$
16	5.2×10^{-1}	1.4×10^{-1}
32	1.1×10^{-1}	1.8×10^{-2}
64	2.5×10^{-2}	2.3×10^{-3}
128	6.5×10^{-3}	2.9×10^{-4}
256	1.6×10^{-3}	3.6×10^{-5}
512	4.2×10^{-4}	2.4×10^{-5}
1024	8.1×10^{-5}	2.4×10^{-5}

*Except for A2 with 512 steps /~ and 1024 steps /~ where there is a curious phase shift of about 90° and a marked drop in amplitude of the last lobe plotted. This effect is quite likely connected with round-off errors.

STEPWISE ERRORS

The truncation error per step is of order h^3 for A1 and of order h^4 for A2. Thus ratios of the forms

$$\frac{C^2_{1,h}}{C^2_{1,\frac{h}{2}}} \sim 4$$

$$\frac{C^2_{2,h}}{C^2_{2,\frac{h}{2}}} \sim 8$$

would indicate that the stepwise errors are due to truncation rather than to round-off. Actual ratios are listed in Table II.

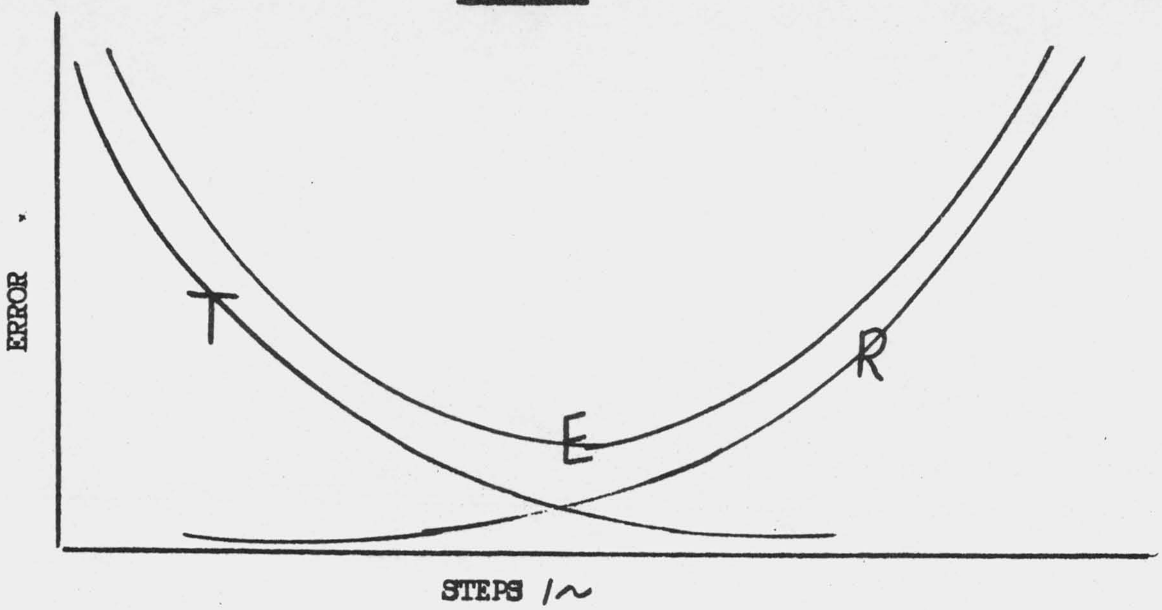
TABLE II

STEPS /~	$C^2_{1,h}/C^2_{2,h}$	$C^2_{2,h}/C^2_{2,\frac{h}{2}}$
16	4.7	7.8
32	4.4	7.8
64	3.8	7.9
128	4.1	8.1
256	3.8	1.5
512	5.2	1.0
1024	---	---

It would then appear that round-off error is negligible for A1 at least thru 1024 steps /~ and for A2 thru 256 steps /~ . The appearance of round-off error is rather dramatic in the case of A2 at 512 steps /~ . This suggests the concept of an "optimum" step size h_o which for A2 and the problem under consideration corresponds to about 256 steps /~ .

Although evidence presented here is rather scant, it seems a reasonable conjecture that round-off error /~ R, truncation error /~ T, and total error /~ E behave somewhat as indicated by Figure 1.

FIGURE I



This suggests the concept of a minimum error /~ step size h_m which for A2 and the problem under consideration corresponds to about 1024 steps /~.

COMPARISON OF ERRORS

For the purpose of comparison of error /~ using A1 against the error /~ using A2 the ratios $C^2_{1,h} / C^2_{2,h}$ are listed in Table III.

TABLE III

STEPS /~	$C^2_{1,h} / C^2_{2,h}$
16	3.7
32	6.1
64	10.9
128	22.4
256	44.4
512	17.5
1024	3.4

In the absence of significant round-off $C^2_{1,h}$ would be about 2×10^{-5} for 2048 steps /~ which is of about the same order as $C^2_{2,h}$ for 256 steps /~. It might be interesting to know the optimum step size h_o, if indeed such exists, for A1.

H. Shaw
H. Shaw

HS:lbg

Note: Figures 2 through 10 are not included with this Appendix and can be obtained by request to Applied Physics Laboratory.

Appendix D

Some Experiments in the Numerical Solution of Differential Equations at The Ramo-Wooldridge Corporation

by

S. D. Conte

April 3, 1957

1. Introduction. At the present time the Computing Center at The Ramo-Wooldridge Corporation leans heavily on the Runge-Kutta method as modified by Gill to integrate systems of first order differential equations. Three routines are currently in use: a real fixed-point Runge-Kutta-Gill; a real floating point Runga-Kutta-Gill; a complex floating point Runge-Kutta-Gill. In most cases these routines give satisfactory results. However, they suffer from some distinct disadvantages which may be summarized briefly as follows:

a) The difficulty of estimating the local error.

b) The necessity of evaluating the derivatives 4 times for each step with a corresponding increase in computing time.

c) The difficulty of controlling the growth of round-off error, particularly in floating point operations.

A program of experimental research was recently initiated with the following objectives.

I. A comparison of multi-step methods with Runge-Kutta type methods.

II. Provision for adequate control of round-off errors.

III. Possible development of new methods.

Some progress has been made toward each of these objectives. This report contains a summary of this progress.

2. Integration based on the Adams-Moulton Formulas. Two multi-step methods of fourth order accuracy are in common use for solving differential equations--those of Milne and Adams-Moulton. Both are of the predictor-corrector type. The Adams-Moulton formulas were given preference over those of Milne because

they are essentially more stable [See, e.g., Hildebrand, Introduction to Numerical Analysis, pp. 202-208] . Methods of this type have the advantage that one can estimate the local truncation error, and in addition they require fewer derivative evaluations than Runge-Kutta methods. However, they have the disadvantage, apart from the possibility of instability, of requiring a special starting routine. A brief description of the Adams-Moulton method, which incorporates automatic adjusting of the interval size, follows.

A. The starting method. At the present time 4 successive values of the dependent variable are obtained by using the modified Euler method for the second point, and increasingly more accurate formulas for the third and fourth points. Since the local error in the modified Euler method is $O(h^3)$ and that of the Adams method is $O(h^5)$, the step size must be smaller in the starting routine than that anticipated in the general routine to yield comparable degrees of accuracy. The factor by which the normal step size is to be reduced for the starting routine depends on the values of the derivatives of the functions in the neighborhood of the initial point, and hence is difficult to estimate in advance. As a general rule if h is the normal step size anticipated in the general routine, we have been using $\frac{1}{8}$ h for the starting routine. If the test described in Section B calls for halving at any time during the computation of the starting values, this step size is halved and the starting routine re-entered.

B. The predictor-corrector formulas. The system of equations is assumed to be in the form

(1) $$y'_i = f_i\,(x, y_1, y_2, \ldots, y_N), \quad (i = 1,2,\ldots,N),$$

$$y_i\,(x_o) = y_{io} \qquad (i = 1,2,\ldots,N).$$

Let y_{ij} be the value of y_i at $x = x_j$ and y'_{ij} the value of the derivatives of y_i at $x = x_j$, and let h be the step increment. Then the predictor-corrector formulas are respectively

(2) $$y^{(p)}_{i,j+1} = y_{ij} + \frac{h}{24}\,(55y'_{ij} - 59y'_{i,j-1} + 37y'_{i,j-2} - 9y'_{i,j-3}) \;,$$

$$(3) \qquad y^{(c)}_{i,j+1} = y_{ij} + \frac{h}{24}\left(9y'^{(p)}_{i,j+1} + 19y'_{ij} - 5y'_{i,j-1} + y'_{i,j-2}\right)$$

When $y^{(p)}_{i,j+1}$ has been obtained from (2), $y'^{(p)}_{i,j+1}$ is obtained from (1). Then an application of (3) yields $y^{(c)}_{i,j+1}$ and (1) then yields $y'^{(c)}_{i,j+1}$. To estimate the truncation error at each step we form

$$(4) \qquad \epsilon_{i,j+1} = \frac{1}{14}\left|\frac{y^{(p)}_{i,j+1} - y^{(c)}_{i,j+1}}{y^{(c)}_{i,j+1}}\right|,$$

for each i and denote the maximum error by E_{j+1}, i.e.

$$(5) \qquad E_{j+1} = \max \epsilon_{i,j+1} \quad (i = 1,\ldots,N).$$

Thus E_{j+1} provides an estimate of the number of significant digits in the corrected value of $y_{i,j+1}$. This estimate can be used to decide whether the integration interval should be doubled, halved or left as it is. The programmer will normally specify the minimum number of significant digits which he desires to maintain throughout the integration--say, $\overline{E}$. Normally the routine will determine a number $\underline{E} = \frac{1}{M}\overline{E}$ to be used for doubling the interval, although M may be changed by the programmer. E_{j+1} is then tested against $\overline{E}$. If $E_{j+1} \geqslant \overline{E}$, the interval must be halved. If $E_{j+1} < \overline{E}$, the routine then tests E_{j+1} against $\underline{E}$. If $E_{j+1} < \underline{E}$, the interval is doubled. The value of M to be used is largely a matter of experimentation. M = 100, in some problems, gave very good results.

The test (4) is not very satisfactory near a zero of a function due to cancellation of significant digits. Thus the test will often call for unnecessary halving even when the predicted and corrected values are very close to each other. To avoid this difficulty the routine tests the corrected value of y for relative size. If its relative magnitude is small, the estimate (4) is replaced by the estimate

$$\epsilon_{i,j+1} = \left|y^{(p)}_{i,j+1} - y^{(c)}_{i,j+1}\right| .$$

The corrector formula is used only once since it has been found that repeated application of the corrector formula will not, in general, improve the answers and, indeed, may in some cases yield poorer results.

C. <u>The doubling and halving formulas</u>. Assume that the integration has proceeded to the point j and that the error test calls for halving the interval. At this point $y_{i,j}$, $y_{i,j-1}$, $y_{i,j-2}$, $y_{i,j-3}$ are stored and we must compute the intermediary values $y_{i,j-3/2}$, $y_{i,j-1/2}$. The formulas used have an error of $O(h^7)$ and are given in [1]:

$$y_{i,j-3/2} = \frac{1}{256}(12y_{i,j} + 135y_{i,j-1} + 108y_{i,j-2} + y_{i,j-3}) + \frac{h}{256}(-3y'_{i,j} - 54y'_{i,j-1} + 27y'_{i,j-2}), \tag{6}$$

$$y_{i,j-1/2} = \frac{1}{256}(80y_{ij} + 135y_{i,j-1} + 40y_{i,j-2} + y_{i,j-3}) + \frac{h}{256}(-15y'_{ij} + 90y'_{i,j-1} + 15y'_{i,j-2}). \tag{7}$$

Using the 4 consecutive values $y_{i,j-3/2}$, $y_{i,j-1}$, $y_{i,j-1/2}$, y_{ij} and their computed derivatives the next point may be computed using equations (2) and (3) and an interval size of h/2.

If the error test calls for doubling the interval, assuming that we have stored $y_{i,j+1}$, $y_{i,j}$, $y_{i,j-1}$, $y_{i,j-2}$ and their derivatives we use the formula

$$y_{i,j+3} = -340y_{i,j+1} - 80y_{i,j} + 405y_{i,j-1} + 16y_{i,j-2} + h(120y'_{i,j+1} + 480y'_{i,j} + 180y'_{i,j-1}). \tag{8}$$

The computation is then continued using the values $y_{i,j+3}$, $y_{i,j+1}$, $y_{i,j-1}$, $y_{i,j-3}$ and their derivatives using an interval size of 2h.

After doubling of an interval has taken place, the routine is prevented from doubling again until 3 more points have been computed.

The routine also incorporates an option which will not allow the interval size h to exceed a certain preassigned bound.

3. <u>Some comparisons of RKG and Adams-Moulton methods</u>.

A. <u>Storage</u>. The RKG subroutine requires 90 words of storage as compared with 280 for the AM method. The RKG method is also more economical of storage during the computation since it requires less storage of past information.

B. Speed. The AM method is considerably faster by a factor of 2 or 3 although this will vary depending upon the complexity of the derivative functions. In general the more complicated the functions the greater the relative advantage of the AM method will be.

C. Accuracy. The two methods were tested using several examples. For the following standard problem

$$y'' + \left(\frac{\pi}{180}\right)^2 y = 0, \quad y(0) = 1, \; y'(0) = 0, \quad 0^\circ \leq x \leq 720^\circ, \tag{9}$$

whose solution is $y = \cos \frac{\pi}{180} x$ the results are given in Table I for two step sizes. The error measured in units in the 8^{th} decimal place reaches relative maxima and minima at very nearly the same points by both methods.

Table I

x	50°	190°	360°	540°	720°
R.K.G. $h = 1^\circ$	+47	-327	+638	-960	+1278
A.M. $h = 1^\circ$	+12	-92	+182	-270	+362
R.K.G. $h = .5^\circ$	+94	-640	+1267	-1904	+2541
A.M. $h = .5^\circ$	+25	-183	+361	-545	+738

Graph II indicates the error curves for both methods again at step sizes of $h = 1^{\circ}$ and $h = .5^{\circ}$. Both the graph and Table I show that the errors by the RKG method are roughly 4 times those of the AM method. Both methods show clearly that, for the step sizes considered here, reducing the interval size by 1/2 multiplies the errors by 2, a result which is clearly attributable to an increased accumulation of round-off error.

Graph I shows the error curves for step sizes of 2°, 1° and $.5^{\circ}$ by the AM method. The errors for $h = 2^{\circ}$ are again about 1/2 of those for $h = 1^{\circ}$. Using a variable step size the results are not as good as at $h = 2^{\circ}$ but slightly better than those at 1°. With a variable step size the interval was doubled up to a maximum of 8°.

Table II gives comparative results for the equation $y' = y$, $y(0) = 1$ whose solution is $y = e^{x}$. The results are the errors to 8 significant digits.

Table II

h	x	1	2	3	4	5	6	7	8	9	10
.0625	RKG	-12	-69	-30	-104	-34	-124	-272	-113	-339	-102
.0625	AM	5	26	10	38	13	41	96	39	120	37

4. Control of round-off error. It is apparent that a large portion of the error in the examples given above are due to round-off. In order to determine more precisely just what this portion is, some experiments were conducted using partial double precision operations. In forming the value of $y_{i,j+1}$ by either the RKG or AM methods one forms an increment Δy_j and adds this to y_j, i.e.

$$y_{i,j+1} = y_{ij} + \Delta y_{ij} .$$

The major contribution to round-off error does not occur in forming Δy_{ij} since this is a quantity of small magnitude compared to y_j but rather in forming the sum. Thus if y_{ij} is carried in double precision and the sum $y_{ij} + \Delta y_{ij}$ is found in double precision, the major part of the round-off error should be controlled. In forming Δy_{ij} the single precision part of y_{ij} and of all previous values of y is used. Of course, complete double precision operations require an excessive amount of computing time. However, the time required for the partial double precision operation described above is almost negligible. The amount of additional storage required is N registers, N being the number of equations in the system. For the equation $y'' + (\frac{\pi}{180})^2 y = 0$, $y(0) = 1$, $y'(0) = 0$, the results are given in Table III for interval sizes of $h = 1^\circ$, $\frac{1}{2}^\circ$ and $\frac{1}{4}^\circ$ using the AM method. The figures again are maximum errors in $y = \cos \frac{\pi}{180} x$ in units in the eighth decimal places although values at intermediate points are given for comparison with Table II since the maximum errors occur at different points.

Table III

h \ x	50°	110°	180°	300°	360°	450°	540°	630°	720°
1°	3	8	1	23	1	39	1	55	1
$\frac{1}{2}^\circ$	3	9	0	24	1	41	1	58	1
$\frac{1}{4}^\circ$	3	9	1	24	1	41	1	58	1

This table shows that at least one additional significant digit of improvement is obtained when partial double precision arithmetic is used. Since the truncation error at 1° is completely negligible when dealing with numbers with 8 significant digits, the errors given in Table III are almost all directly due to round-off. Table I and Graph II show that when no attempt is made to control round-off the error doubles when one goes from a step size of 1° to a step size of $\frac{1}{2}^\circ$. Table III shows that the error is approximately the same as one goes from a step size of 1° to one of $\frac{1}{2}^\circ$ and to one of $\frac{1}{4}^\circ$. Hence the growth of round-off is being very effectively controlled by the partial double precision operation described above.

Although direct figures are not available, some experimentation shows that the use of partial double precision with the RKG method results in an even more striking reduction in round-off error.

5. A proposed subroutine for the 1103-A. On the basis of the experience gained from the experiments described above, the Computing Center has undertaken the writing of a comprehensive floating point general purpose subroutine for solving differential equations which incorporates the following features:

A. The use of RKG as a starting routine.

B. The option of continuing with RKG or switching to the AM method at any time during the computation.

C. Automatic doubling or halving of the step interval if the AM method is used. Doubling and halving are accomplished by making use of the RKG method. If upon leaving an RKG step the test calls for halving, the routine should return to the original starting point and recompute 4 successive values using RKG and one half the original step size.

D. Partial double precision operations throughout for either RKG or AM.

6. Application of Gaussian quadrature to the solution of differential equations. Gauss' quadrature formulas have been used with remarkable success to evaluate integrals. H. Flatt suggested that this quadrature formula could also be used to integrate differential equations. The Gaussian quadrature formula is given by

$$\int_a^b f(x)dx = \frac{b-a}{2} \sum_{i=1}^{n} a_i \, f(x_i(\tfrac{b-a}{2}) + \tfrac{b+a}{2}) + R_n(f) \tag{10}$$

where $x_i = x_{in}$ is the i^{th} root of the Legendre polynomial $P_n(x)$ and

$$a_i = a_{i,n} = \frac{1}{P_n'(x_i)} \int_{-1}^{1} \frac{P_n(x)}{x-x_i} dx \, . \tag{11}$$

If $f(x)$ has continuous derivatives of order $2n$ in the interval (a,b) then the error $R(f)$ is given by

$$R_n = \frac{f^{(2n)}(\xi)}{(2n)!\, k_n^2}, \qquad a < \xi < b. \tag{12}$$

and

$$k_n = \frac{\binom{2n}{n} (2n+1)^{\frac{1}{2}}}{(b-a)^{n+\frac{1}{2}}}.$$

Thus the formula (10) is exact for a polynomial of degree $2n - 1$.

For integrating a single differential equation we have

$$y(x + h) = y(x) + \int_x^{x+h} y'(t)\, dt$$

Using (10) to replace the integral we obtain

$$y(x + h) = y(x) + \frac{h}{2} \sum_{i=1}^{n} a_i\, y'\left[x + \frac{h}{2}(1 + x_i)\right] + R_n(y'). \tag{13}$$

To evaluate $y'\left[x + \frac{h}{2}(1 + x_i)\right]$ we may use the RKG method. Since the error is RK is $O(h^5)$, we take $n = 3$ in (13) with an error of $O(h^6)$. Formula (13) then becomes

$$y(x + h) = y(x) + \frac{h}{18} \left\{ 5y'\left[x + \frac{h}{2}\left(1 - \frac{\sqrt{15}}{5}\right)\right] + 8y'\left(x + \frac{h}{2}\right) + 5y'\left[x + \frac{h}{2}\left(1 + \frac{\sqrt{15}}{5}\right)\right] \right\} \tag{14}$$

Thus in integrating over an interval of length h one uses the RKG method 3 times to obtain $y'(x + \frac{h}{2})$, $y'\left[x + \frac{h}{2}\left(1 - \frac{\sqrt{15}}{5}\right)\right]$ and $y'\left[x + \frac{h}{2}\left(1 + \frac{\sqrt{15}}{5}\right)\right]$. Application of the Gaussian formula (14) then yields the value $y(x + h)$. To be comparable a single Gaussian step would be equivalent to 4 equally spaced RKG steps.

This method was tested on the equation (9). The results, using floating point arithmetic, are given in Table IV and are again the maximum errors in cos x in units in the eighth decimal place. The Gaussian method is seen to be much more accurate than RKG and somewhat more accurate than AM. Similar results were obtained for the exponential equation.

The additional coding required for this method is minor and there should be a saving of machine time since one RKG step is replaced by a simple sum as shown in (14). This use of the Gaussian formula seems to be new and because of the striking improvement in accuracy in the cases tested deserves continued further investigation.

Table IV

	Gaussian		RKG	
x°	$h = 4^\circ$	$h = 2^\circ$	$\bar{h} = 1^\circ$	$\bar{h} = 0.5^\circ$
8	0	1	9	12
56	-1	1	46	96
192	-16	-35	-327	-640
368	33	71	640	1264
540	-57	-116	-960	-1904
720	76	156	1278	2541

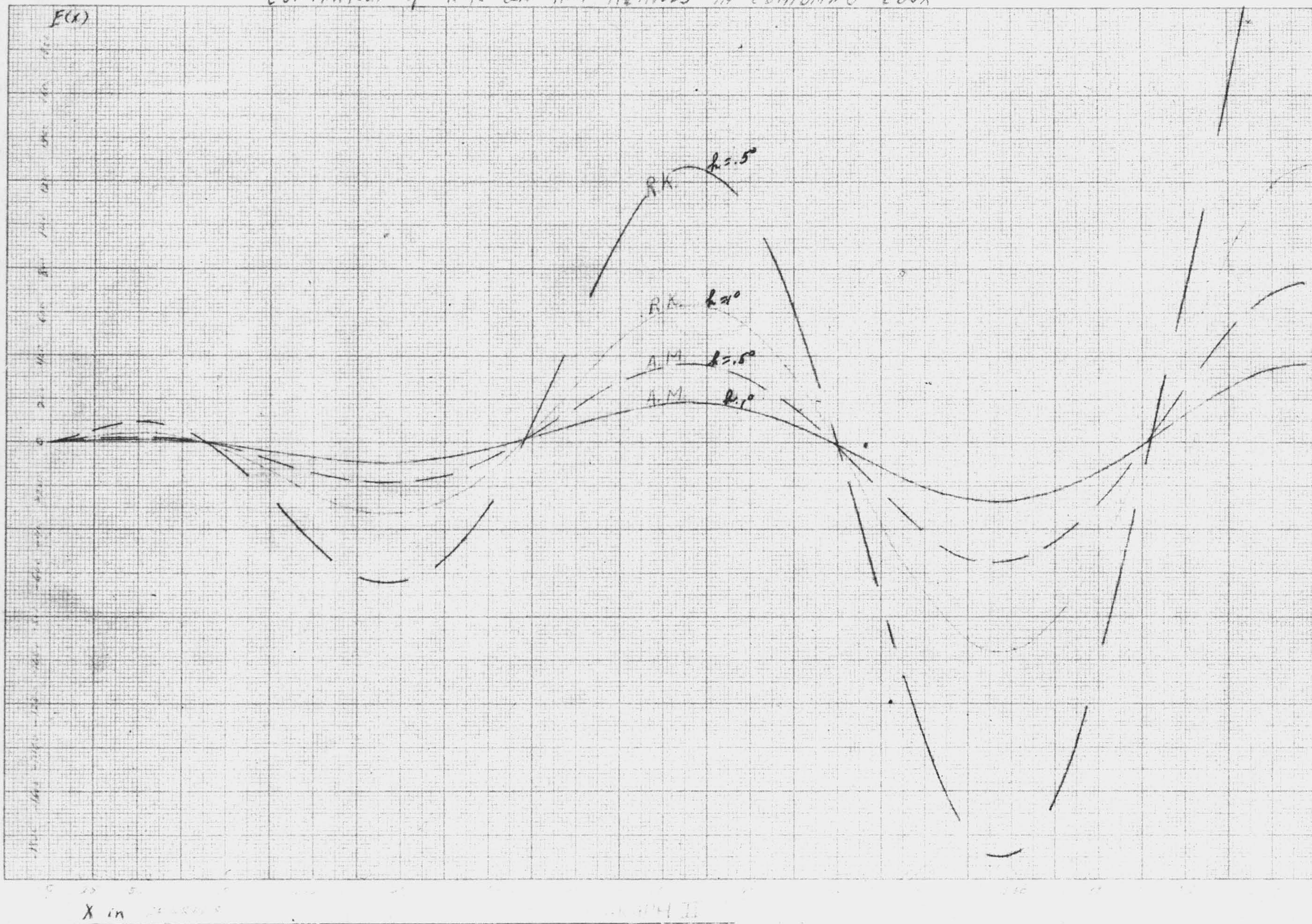
References

1. Edelman, "An interpretive subroutine for the solution of systems of first order ordinary differential equations on the "650" Calculator", Report RCA Laboratories.

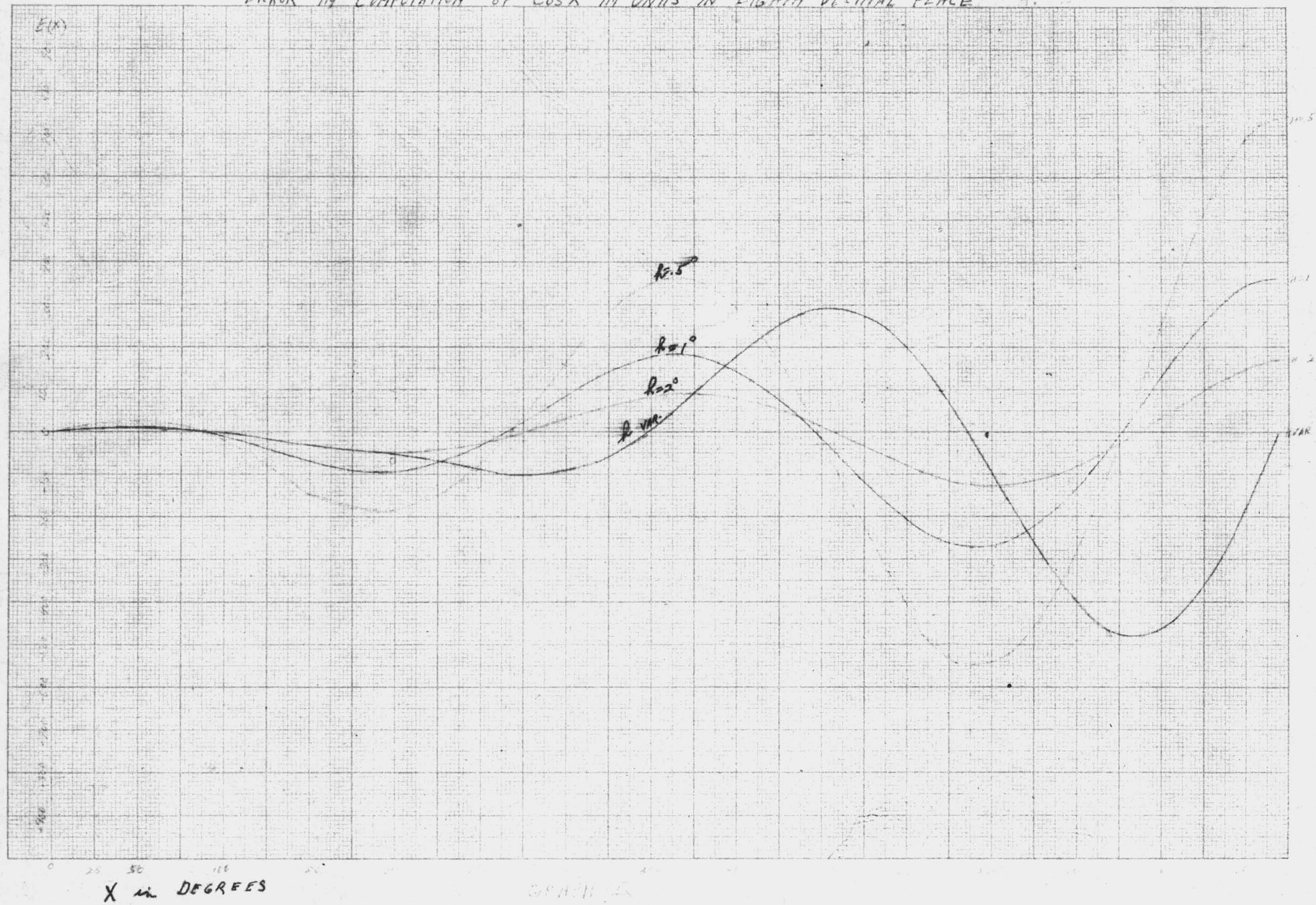
2. G. H. Keitel, "An extension of Milne's three-point method", JACM, July, 1956.

3. H. Flatt and S. Conte, Integration of ordinary differential equations, NN-21, The Ramo-Wooldridge Corporation, August, 1956.

COMPARISON of R.K and A.M. METHODS IN COMPUTING COS X



ERROR IN COMPUTATION OF COS X IN UNITS IN EIGHTH DECIMAL PLACE



Appendix E

Methods Employed by the Various Installations for Integrating Ordinary Differential Equations

	Installation	Method
1.	Applied Physics Laboratory	Method of Heun
2.	Applied Mathematics Section Wright Air Development	Method of Integral Equations
3.	Holloman Air Force Base	Runge-Kutta-Gill with interval modifier (takes two steps forward with interval h, and one back with interval 2h to determine optimum step.
4.	WCRRY, Wright Air Development Center	Simultaneous 2nd order equations; employ first order forward differences and central differences.
5.	WCRRU, Wright Air Development Center	a. Runge-Kutta, third order b. Levy-Baggott method for 2nd order equations with first order term missing
6.	Boeing	Modified Euler
7.	Operations Research Office	None
8.	Lockheed	Adams method with backward differences

Problems Proposed by Dr. G. Blanch for Solution

1) $$y'' = \frac{8y^2}{1 + 2x}$$

$y(0) = 1, \quad y'(0) = -2$

Solution: $y = \dfrac{1}{1 + 2x}$

2) $x(y'' + y) + y' = 0$

$y(0) = 1, \; y'(0) = 0, \quad y''(0) = -\frac{1}{2}$

Solution: Bessel Function $J_o(x)$.

Instructions:

1) Carry out integration to $x = 20$ for several mesh sizes, say $h = 2^{-k}$ where $k = 1, 3, 5$, (7 and 9 if possible)
2) Plot error function for each h.
3) Take cognizance of rounding procedure used in course of computation.

Appendix G

Mathematics Committee

Recommendations to Policy Committee

1. This committee recommends that installations be informed of the Trans-USE feature which permits conversion of standard USE language floating point routines to a program which will operate on any fixed point machine. Such a feature ought to be incorporated into the USE compiler.

2. Clarification is requested in regard to subroutine and general packages format and structure. Also means of transmittal or distribution.

3. As a result of the deliberations on methods of solving ordinary differential equations, it is recommended that the following actions of the Mathematics Committee be approved:

    a) Ramo-Wooldridge will prepare a floating point subroutine having the features

        i) Use of Runge-Kutta as a starting procedure

        ii) Option of continuing with Runge-Kutta or switching to the Adams-Moulton method at any time in the stepping.

        iii) Automatic doubling and halving of step interval if the Adams-Moulton method is used.

        iv) Partial double precision operations.

    b) Wright Field will undertake the responsibility to investigate a method described by Dr. Blanch which changes the differential equation problem to an integral equation problem.

    c) Remington Rand volunteers to prepare a code employing the Gaussian quadrature technique.

    d) Dr. Blanch has consented to prepare a testing program for these methods in order to determine characteristics with respect to truncation and round-off for each.

4. Recommendations for topics at future meetings.

    For the next meeting: Eigenvalues and Eigenvectors of Matrices

    For the following meeting: Further study on Ordinary Differential Equations in the light of the research proposed at this meeting.

BCC- 73

April 22, 1957

TO: The Mathematics Committee of the Use Organization

FROM: H. Shaw

SUBJECT: Status of USE Spectral Analysis Program

SUMMARY

The computation of the autocorrelation and spectral density has been coded in APL symbolic coding as two separate library subroutines. These routines have not been machine checked.

The remainder of this report consists of the specifications of these routines.

NUMERICAL METHOD

The numerical method employed is that of J. W. Tukey as given in The Sampling Theory of Power Spectra Estimates. The cosines required by the spectral density are computed by using four terms of Taylor's series to obtain $\cos \frac{\pi}{M}$, M = number of lags, and generating the remaining cosines by use of the recursion formula

$$\cos \frac{ph\pi}{M} = 2 \cos \frac{h\pi}{M} \cdot \cos \frac{(p-1)h\pi}{M} - \cos \frac{(p-2)h\pi}{M} .$$

MODES, PARAMETERS, DATA, OUTPUT

The autocorrelation routine operates in one of two modes to compute the data mean $\bar{x}$ and the M + 1 lags $R_0, R_1, \ldots, R_M$ from N data $x_1, x_2, \ldots, x_n$. The spectral density routine uses the output of the autocorrelation routine to compute M + 1 values of the spectral density and their sum.

The data is assumed to be integral, to be such that $|x_j| \leqq 9999$, $j = 1(1)N$, and to be stored starting at core address W for the core mode or drum address V for the drum mode. Both modes leave $\bar{X}$ at W-1 and R_j at W + j, j=0(1)M upon exit. The spectral density routine leaves U_j at W + M + 1 + j, j= 0(1)M and $\sum_{j=0}^{M} U_j$ at W + 2M+ 2 upon exit.

The following code words are required:

$$\begin{array}{llll} A: & 00 & 0MMMM & WWWWW \\ Q: & 00 & NNNNN & \begin{bmatrix} 00000 \\ VVVVV \end{bmatrix} \end{array}$$

The v address portion of Q is zero for the core mode and v for the drum mode.

STORAGE

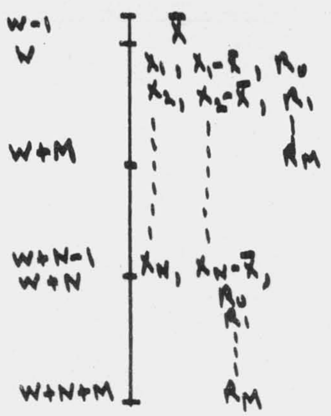
The autocorrelation routine consists of 165 words and the spectral density routine consists of 178 words for a total of 343 words.

Auxiliary storage requirements for the autocorrelation routine consist of a block of N drum locations beginning at drum address V plus a block of 3M + 2 core locations beginning at core address W-1 for the drum mode or a block of N + M + 2 core locations beginning at core address W-1 for the core mode. In either case the spectral density routine requires a block of 3M + 3 core locations beginning at core address W-1.

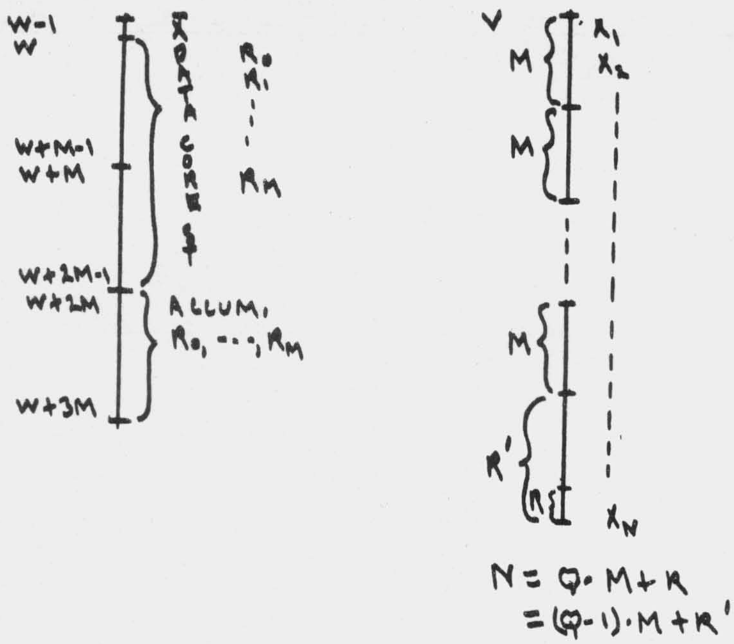
The following diagrams indicate how the auxiliary storage is used:

AUTOCORRELATION

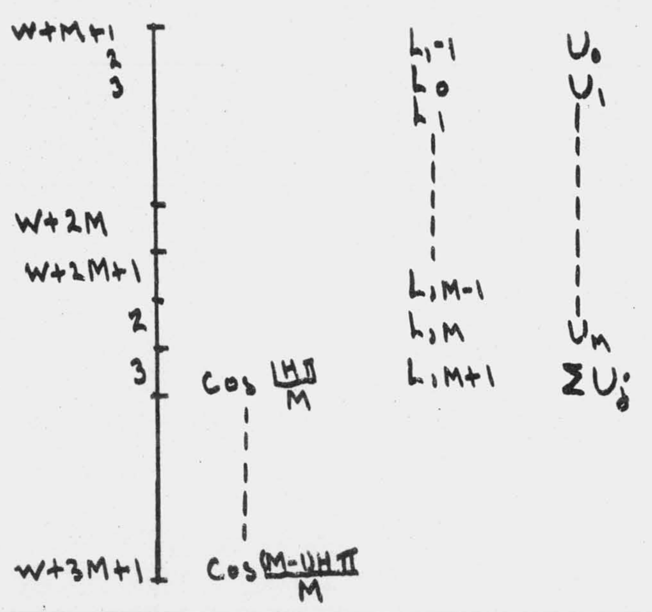
Core Mode



Drum Mode



SPECTRAL DENSITY



RUNNING TIMES

The time required for the autocorrelation routine should not exceed

$$474\ M(N - \frac{M}{2}) + 558N + 951\ M + 2920 \quad \mu s$$

for the core mode or

$$474\ M(N + \frac{M}{2}) + 1790N - 191M + 69900\ \frac{N}{M} - 30400 \quad \mu s$$

for the drum mode.

The time required for the spectral density routine should not exceed

$$1170\ M^2 + 12M + 10273 \quad \mu s$$

The following table of maximum running times is based on the assumption that $M \sim \frac{1}{10} N$. The last column is obtained by use of the core mode times for N up to and including 4000 and drum mode times for N greater than 4000.

N	A(Core)	A(Drum)	A and SD
10	13 MS	690 MS	25 MS
100	.52 SEC	1.4 SEC	.53 SEC
1000	46 SEC	52 SEC	58 SEC
2000	3 MIN 0 SEC	3 MIN 20 SEC	3 MIN 47 SEC
3000	6 MIN 45 SEC	7 MIN 30 SEC	8 MIN 30 SEC
4000	12 MIN 5 SEC	13 MIN 25 SEC	15 MIN 12 SEC
5000	....	20 MIN 55 SEC	25 MIN 48 SEC
10000	....	1 HR 20 MIN	1 HR 40 MIN
15000	....	3 HR 5 MIN	3 HR 50 MIN

H. Shaw
H. Shaw

HS:lbg

Appendix I

THE RAMO-WOOLDRIDGE CORPORATION

LOS ANGELES 45, CALIFORNIA

April 22, 1957

CURVE FITTING ACCORDING TO LEAST SQUARES CRITERION EMPLOYING ORTHOGONAL POLYNOMIALS

Coded by: L. Stoller

Description by: D. Morrison

A system $p_0, p_1, \ldots, p_k$ of orthogonal polynomials is defined as follows: (a) p_j is a polynomial of degree j with leading coefficient one. (b) If $j \neq s$, then

$$\sum_{i=1}^{N} p_j\,(x_i)\; p_s\,(x_i) = 0.$$

The required polynomial $P_k(x)$ is then known to be

$$P_k(x) = \sum_{j=0}^{K} S_j\; p_j\,(x), \tag{1}$$

where

$$S_j = \frac{\sum_{i=1}^{N} y_i\; p_j\,(x_i)}{\sum_{i=1}^{N} \left\{ p_j\,(x_i) \right\}^2} .$$

The routine uses the fact that the polynomials p_i may be found by the recurrence relations;[1]

$$(2) \quad \begin{cases} p_o(x) = 1 \\ p_1(x) = x\; p_o\,(x) - \alpha_1\; p_o\,(x) \\ \qquad \cdots \\ p_{j+1}(x) = x\; p_j(x) - \alpha_{j+1}\; p_j(x) - \beta_j\; p_{j-1}(x). \end{cases}$$

where

$$\alpha_{j+1} = \frac{\sum_{i=1}^{N} x_i \left\{ p_j\,(x_i) \right\}^2}{\sum_{i=1}^{N} \left\{ p_j\,(x_i) \right\}^2}$$

---

1 Forsythe, G. E. Generation and Use of Orthogonal Polynomials for Data Fitting with a Digital Computer. To appear in SIAM.

$$\beta_j = \frac{\sum_{i=1}^{N} \left\{ p_j \, (x_i) \right\}^2}{\sum_{i=1}^{N} \left\{ p_{j-1} \, (x_i) \right\}^2}$$

The routine computes the recurrence constants α_{j+1}, β_j (which depend only on the data points x_i), and the coefficients s_j (which depend on the functional values y_i).

The routine also computes recursively approximations[1] $\hat{\delta}_i^{\,2}$ to $\delta_i^{\,2}$ $(i=0,\ldots, k)$ as follows

$$\hat{\delta}_{-1}^{\,2} = \sum_{i=1}^{N} y_i^{\,2}$$

$$\hat{\delta}_j^{\,2} = \hat{\delta}_{j-1}^{\,2} - s_j^{\,2} \sum_{i=1}^{N} \left\{ p_j(x_i) \right\}^2, \qquad j=0,\ldots, k.$$

The routine was tested for various degrees, and polynomials of 50th degree were obtained without any trouble. The results of the test runs indicated that the routine gives extremely good results if the data points are equally spaced, and that the accuracy decreases as the points tend to become clustered.

3. <u>Operating Instructions</u>.

In order to include this routine in a particular program to be compiled, the following rules must be observed:

a. The storage locations referred to below may be drum or core locations, except that all core addresses must be greater than 1024 and certain drum locations are excluded as indicated.

b. The instructions of this routine must be preceded by a card containing the instruction

, , RW, EQUALS, α

1 If the routine were not subject to rounding errors, we would have $\hat{\delta}_i^{\,2} = \delta_i^{\,2}$.

where α is the first cell of a region of 457 cells allocated to the storage of this routine. This region cannot be assigned to the following locations

0 - 1777b	(Routine execution region)
47774b - 54015b	(Reserved for output)
76351b - 77777b	(Partial core image)

c. The following alphabetic symbols together with 2 decimal integers may not be used as tags by the programmer:

RW, P, V, S, N, R, L, C, DP, AP, H, T, W, CM, X

d. Entrance to this routine is as follows:

β	RJ	α	$\alpha + 1$
$\beta + 1$	KK	LLLLL	00NNN
$\beta + 2$	00	000TT	000FF
$\beta + 3$	00	DDDDD	00MMM

where

KK is the degree (k) of fit required. ($k \leq 63$.)

LLLLL is the first cell of a region containing the table of x_i's followed by the table of corresponding y_i's.

NNN is the number (N) of data points. ($N \leq 300$.)

TT is the binary scaling factor (T) of the data points t_i.

FF is the binary scaling factor (F) of the functional value f_i. (The t_i and f_i must be scaled so that

$$\max_i \left| t_i \right| 2^T < 2^{34} - 1 \quad \text{and} \quad \max_i \left| f_i \right| 2^F \leq 2^{34} - 1 \text{ .)}$$

DDDDD is the first cell of a region containing the list of additional arguments (if any) $t_{N+1}, \ldots, t_{N+M}$ for which $Q_k(t)$ is to be evaluated.

<u>MMM</u> is the number (m) of additional arguments for which $Q_k(t)$ is to be evaluated.

The parameter word $\beta + 3$ <u>must</u> be zero if there are no additional arguments for which $Q_k(t)$ is to be evaluated.

e. Control will be returned to the cell immediately following the parameter word $\beta + 3$.

f. Cells 1-320 will be destroyed by the execution of this routine.

4. <u>Execution Time</u>.

The time T of operation for the basic routine is approximately given by $T \sim \left\{ (.0056N + .025)k + .5 \right\}$ seconds. This time was estimated on the 1103, and will be shorter on the 1103A. It should be noted that even for the maximum degree and the maximum number of data points, the time is still well under two minutes.

5. <u>Output</u>.

The following results are available to the programmer in the indicated locations upon exit from this routine. Normally, the user will be interested only in a., d., e., and f.

a. $Q_k(t_i)$, is stored in cells $47777_b + i\,(i=1,\ldots,N)$.

b. Recurrence constants α_i, β_i, and coefficients S_i are listed as follows:

$$\alpha_i \text{ is in cell } 53411_b + 3(i-1)(i=1,\ldots, k)$$
$$\beta_i \text{ is in cell } 53412_b + 3(i-1)(i=1,\ldots, k)$$
$$S_i \text{ is in cell } 53410_b + 3i \ \ (i=0, 1,\ldots, k)$$

c. The degree k of fit, scaled at zero is in cell 47774_b.

d. $D_k^2 \cdot 2^{-\gamma}$ is stored in 47775_b, where γ is an integer scaled at zero and stored in 47776_b.

e. The $i^{\underline{th}}$ residual, $f_i - Q_k(t_i)$, is stored in $52733_b + i\ (i=1,\ldots,N)$.

f. If there are any additional arguments $t_{N+1},\ldots, t_{N+m}$, then $Q(t_{N+i})$ is stored in cell 52257 + i (i=1,...,m).

g. The approximation $\hat{\delta}_i^2$ to δ_i^2 is stored in 53712_b + i (i=-1,...,k). In addition, δ_k^2 is also stored in 47777b.

6. Special Instructions.

For many purposes, the results contained in a., d., e. and f. of Section 5 will be sufficient in a least squares fitting problem. The instructions of this section are intended to aid in the use of the routine when these results are not sufficient. In particular, the user may wish to know how to (a) evaluate $Q_k(t)$ for any given value of t, (b) obtain the coefficients of $Q_k(t)$ explicitly or (c) investigate the effect of increasing the degree of the polynomial upon the sum of squares of the residuals.

It is necessary for these purposes to investigate the transformations discussed in Section 2 more closely. The transformations are

$$x = at + b$$

$$y = Af + B,$$

where

$$a = \frac{4}{t_2 - t_1}, \qquad b = -2\,\frac{t_2 + t_1}{t_2 - t_1}$$

$$A = \frac{4}{f_2 - f_1}, \qquad B = -2\,\frac{f_2 + f_1}{f_2 - f_1},$$

and

$$t_2 = \max_i \; t_i \;, \; t_1 = \min_i \; t_i$$

$$f_2 = \max_i \; f_i \;, \; f_1 = \min_i \; f_i \;.$$

Hence, to compute the polynomial $Q_k(t)$ at any point t, one proceeds as follows:

a. Compute a, b, A, B.

b. Compute x = at + b.

c. Compute $p_o, p_1, \ldots, p_k$ using (2) of Section 2.

d. Compute $P_k(x)$ using (1) of Section 2.

e. Compute $Q_k(t) = \dfrac{P_k(x) - B}{A}$.

A similar procedure may be followed to obtain the coefficients of $Q_k(t)$. In order to study the effect of increasing the degree of the polynomial upon the sum of squares of the residuals, we note that

$$D_j^2 = \frac{1}{A^2} \delta_j^2 , \quad j = 0, \ldots, k$$

We recall that D_j^2 is the sum of squares of the residuals when the polynomial is of degree j, and that an approximation to δ_j^2 is stored in cell $53712_b + j$.

It is possible to stop the routine as soon as $\hat{\delta}_j^2$ is less than a certain specified amount M. This is done by simply storing M (scaled at 2^{25}) in the cell tagged C03. (After having employed this variation once, the programmer must restore the cell tagged C03 to its normal value of $-(2^{35}-1)$ in order to use the routine in its standard form.)

7. <u>Alarm Conditions</u>.

The routine is known to give best results when the points are more or less uniformly distributed. If the points are very poorly distributed, an alarm condition may result. In this case the following changes may be inserted in the indicated tag locations:

N15	54 00647	32036	(octal)
R33	54 32000	00004	"
H05	54 00647	32036	"
W02	54 32000	00004	"

The effect of the above changes is to replace the interval (-2, 2) by the interval (-1, 1). This increases the chances that the routine will be completed but also decreases the accuracy of the process. The changes should, therefore, be regarded as an emergency measure.

ON ROUTINES FOR LEAST SQUARES CURVE FITTING WITH ORTHOGONAL POLYNOMIALS

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Palo Alto, California

Abstract

Ordinary techniques for the fitting of polynomials to empirical data via the method of least squares are briefly reviewed. A summary of the method of Stiefel which introduces a special set of orthogonal polynomials for the solution of the least squares problem then follows.

It is observed that by this method, the difficulties that can be encountered with the so-called normal equations are completely avoided. Recursion formulas for the computation of the necessary orthogonal polynomials are given and flow charts for the computational routine are included.

Comments on computational experience with routines of this sort are made and some examples of curve fits are discussed.

For Presentation at the

IBM 650 Computation Seminar
Endicott, New York
April, 1957

On Routines For Least Squares Curve Fitting With Orthogonal Polynomials

In Section 6.111 of his book (Ref. 1), Householder briefly summarizes a method of generating a set of orthogonal polynomials which is useful in least squares curve fitting. A more detailed discussion of these polynomials is given by Stiefel (Ref. 2) and their application in other contexts is discussed by Householder, Stiefel, and Forsythe (Ref. 1, Sections 2.22 and 4.23; Ref. 2; and Ref. 3).

The purpose of the present paper is to summarize some of the equations and recursion formulas that are useful for least squares curve fitting applications and to comment on our computational experience with them. Such an effort seems worthwhile since the particular method under discussion appears relatively unknown to computer application personnel.

We start with a set of empirical data points (x_i, y_i); $i = 1, 2, \ldots, N$. We will take x as the independent variable and we will find a polynomial $y^*(x)$ such that

$$\varepsilon^2 = \int_{x_1}^{x_N} [y^*(x) - y(x)]^2 \rho(x)\,dx$$

$$= \sum_{i=1}^{N} [y^*(x_i) - y_i]^2 w_i^2 \qquad (1)$$

is minimized. Here, the weight function $\rho(x)$ is defined as

$$\rho(x) = \sum_{i=1}^{N} w_i^2 \delta(x - x_i), \qquad (2)$$

where $\delta(x-x_i)$ is the Dirac δ-function. It is easily seen that substitution of this weight function into the integral in (1) yields the equation given there. Weight functions of this type permit us to use integrals as well as sums in the expressions that follow and this sheds a little light on the background of the methodology.

At this point, one usually proceeds in standard least squares fashion and derives the so-called normal equations for determining the coefficients of the polynomial $y^*(x)$. However, it is well known that the matrix associated with the normal equations tends to be ill-conditioned, especially when the x_i are equally spaced or nearly so. Its behavior is like that of the Hilbert matrix, which is notably nasty.

When the points are equally spaced, and the weights w_i^2 are all unity, then we already know of a set of orthogonal polynomials that can be used to diagonalize the normal equations. This is the set described by Milne (Ref. 4, Chap. IX). Least squares curve fitting with these polynomials can now be classed as a standard tool of the computing analyst.

With the method to be described, we still have the advantages of orthogonality but we can remove the restrictions of equal spacing and unit weights. The orthogonal polynomials are obtained recursively as follows:

$$
\begin{aligned}
P_0(x) &= 1, \\
P_1(x) &= (x-u_1)\,P_0(x), \\
P_2(x) &= (x-u_2)\,P_1(x) - v_1 P_0(x), \\
&\cdots \\
P_m(x) &= (x-u_m)\,P_{m-1}(x) - v_{m-1} P_{m-2}(x).
\end{aligned}
\qquad (3)
$$

The coefficients u_m, v_{m-1} are obtained from the expressions:

$$u_m = D_{m-1}^{-1} \int_{x_0}^{x_N} x \left[P_{m-1}(x)\right]^2 \rho(x)\, dx$$

$$= D_{m-1}^{-1} \sum_{i=1}^{N}{}' x_i \left[P_{m-1}(x_i)\right]^2 W_i^2, \tag{4}$$

$$V_{m-1} = D_{m-2}^{-1} \int_{x_0}^{x_N} x\, P_{m-1}(x)\, P_{m-2}(x)\, \rho(x)\, dx$$

$$= D_{m-2}^{-1} \sum_{i=1}^{N}{}' x_i\, P_{m-1}(x_i)\, P_{m-2}(x_i)\, W_i^2, \tag{5}$$

where

$$D_m = \int_{x_0}^{x_N} \left[P_m(x)\right]^2 \rho(x)\, dx = \sum_{i=1}^{N}{}' \left[P_m(x_i)\right]^2 W_i^2. \tag{6}$$

It is shown in Sec. 1 of Ref. 2 that

$$\int_{x_0}^{x_N} P_m(x)\, P_n(x)\, \rho(x)\, dx = 0, \quad m \neq n.$$

The recursion (3) terminates in $P_{n-1}(x)$. We can thus obtain approximations to $y(x)$ in the form

$$y^*(x) = \sum_{m=0}^{M}{}' a_m P_m(x), \quad M \leq N-1. \tag{7}$$

Substitution of (7) into (1) leads to the determination of the a_m as

$$a_m = D_m^{-1} \int_{x_0}^{x_N} y(x)\, P_m(x)\, \rho(x)\, dx$$

$$= D_m^{-1} \sum_{i=1}^{N}{}' y_i\, P_m(x_i)\, W_i^2. \tag{8}$$

To get our results in customary form, we write

$$P_m(x) = \sum_{K=0}^{m} b_K^m x^K. \tag{9}$$

The b_k^m can be obtained by recursion as follows:

$$b_k^m = \begin{cases} 1, & m = K \\ 0, & K < 0 \text{ or } K > m \end{cases} \tag{10}$$

$$= b_{K-1}^{m-1} - u_m b_K^{m-1} - V_{m-1} b_K^{m-2}$$

otherwise.

If we write the approximating polynomial as

$$y^*(x) = \sum_{K=0}^{M} C_K^M x^K , \tag{11}$$

then the $C_k^m = \sum_{j=K}^{M} a_j b_K^j$. (12)

For those who like them, flow charts of the basic features of our routine are supplied (Fig. 1 and 2). It is readily observed that this type of routine can be handled very neatly on a machine with indexing and table-look-up features. Numerical weights can be read in with the data, or the weights can be computed as a function of the independent variable before the curve-fit is started. Coding may also be included which transforms the range of the independent variable. We usually normalize the range with the transformation

$$x_i^1 = \frac{x_i - x_o}{x_N - x_o}$$

or

$$x_1^1 = \frac{2x_1 - x_n + x_1}{x_N + x_1} \quad .$$

In most cases we find that normalization is required to prevent large coefficients of oscillating sign which tend to occur when the independent variable is allowed to take numerical values greater than one and then is raised to large powers. A little experimentation with the code will illustrate what is meant here.

One of the nicest features of this code is that it opens many possibilities for experimentation in curve-fitting techniques. For example, by defining the orthogonal functions by

$$\begin{aligned} P_o(x) &= 1, \\ P_2(x) &= (x^2 - u_2)\, P_o, \\ &\cdots \\ P_{2m}(x) &= (x^2 - u_{2m})\, P_{2m-2}(x) - v_{2m-2}\, P_{2m-4}(x) \end{aligned} \tag{13}$$

we get a set of polynomials ideally suited for fitting even functions, and if we use

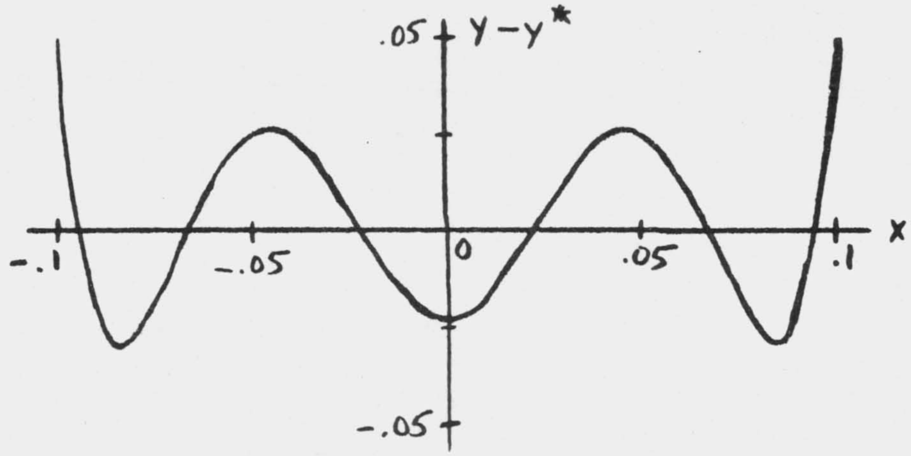
$$\begin{aligned} P_o(x) &= 0, \\ P_1(x) &= x, \\ P_3(x) &= (x^2 - u_3)\, P_1(x), \\ &\cdots \\ P_{2m+1}(x) &= (x^2 - u_{2m+1})\, P_{2m-1}(x) - V_{2m-1}\, P_{2m-3}(x) \end{aligned}$$

we get a set ideally suited to odd functions.

As examples we will use $y = x^6$ and $y = \sin \frac{\pi}{2} x$ taking 41 equally spaced points in $-1 \leqslant x \leqslant 1$. Unit weights are taken. The "best" fifth degree approximation for $y = x^6$ obtained by our routine is

$$y^* = .024048728 - .48785777x^2 + 1.4130909x^4 .$$

The error curve is shown below:

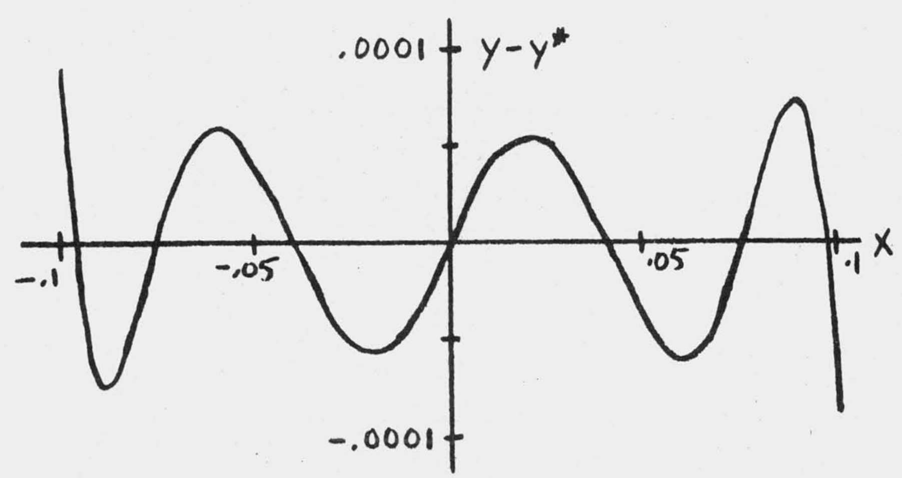


Note that this comes out an even function.

The "best" odd fifth degree approximation for $y = \sin \frac{\pi}{2} x$ obtained by our routine is

$$y^* = 1.570392x - .64244341x^3 + .072143552x^5 .$$

The error curve is:



We have found that by experimenting with weight functions and transformations of the x - axis, that we can usually warp any error curve until it is satisfactory for our purposes. The reader is urged to experiment with his own empirical curve fitting problems for even with the routines described here, we feel that curve fitting is yet an art, not a science.

Finally, a word about operating time. We have found that this routine is faster than routines which invert the matrix associated with the normal equations for polynomials of the third degree or higher. It is obvious that for some degree that this method must get better. In fact, we use this routine for all polynomial fitting, since the routine is about equally as good as the old one for parabolas.

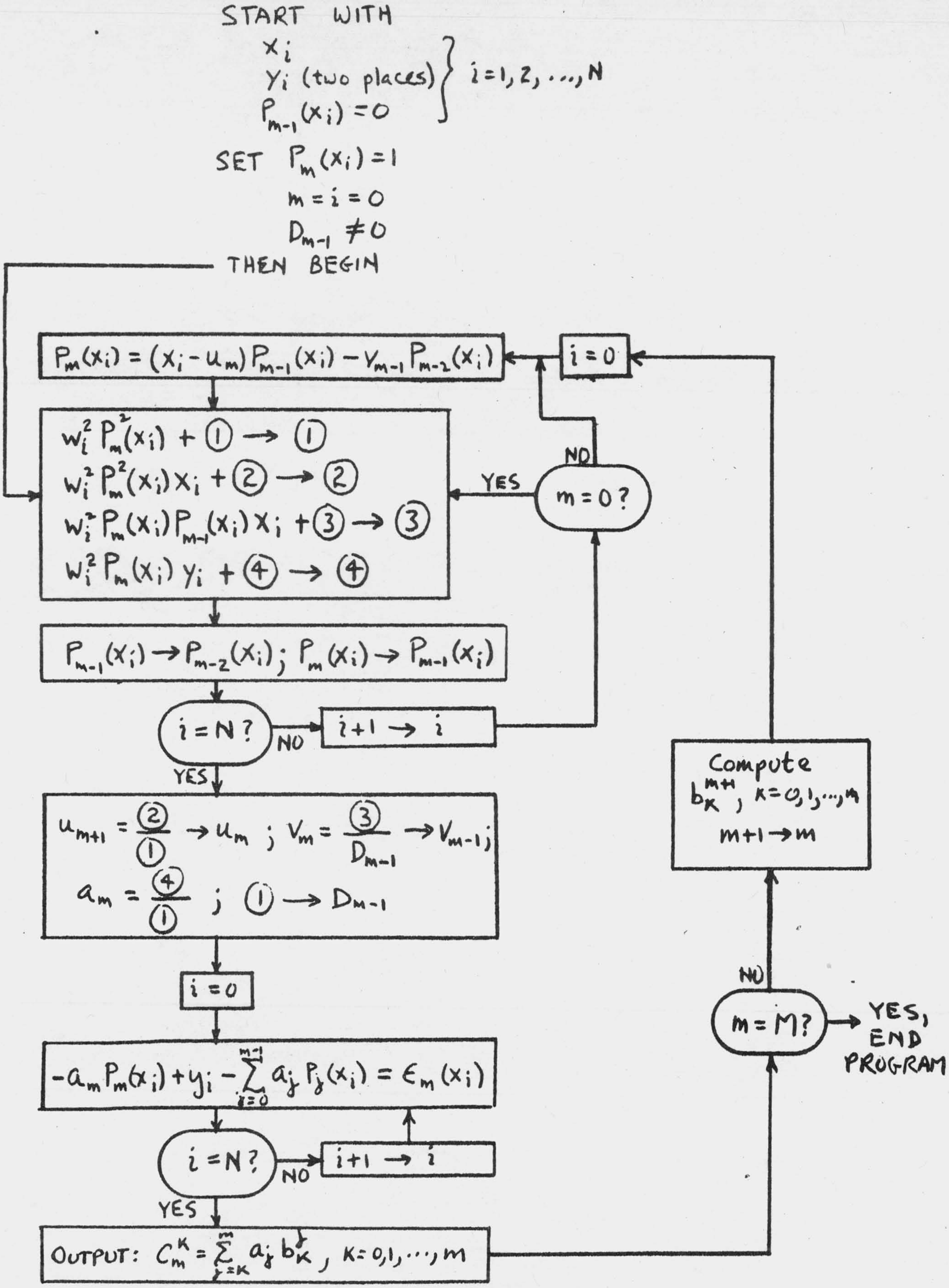

START WITH
x_i
y_i (two places)
$P_{m-1}(x_i) = 0$
$i = 1, 2, \ldots, N$
SET $P_m(x_i) = 1$
$m = i = 0$
$D_{m-1} \neq 0$
THEN BEGIN
$P_m(x_i) = (x_i - u_m) P_{m-1}(x_i) - V_{m-1} P_{m-2}(x_i)$
$i = 0$
$w_i^2 P_m^2(x_i) + ① \rightarrow ①$
$w_i^2 P_m^2(x_i) x_i + ② \rightarrow ②$
$w_i^2 P_m(x_i) P_{m-1}(x_i) x_i + ③ \rightarrow ③$
$w_i^2 P_m(x_i) y_i + ④ \rightarrow ④$
YES
NO
$m = 0?$
$P_{m-1}(x_i) \rightarrow P_{m-2}(x_i)$; $P_m(x_i) \rightarrow P_{m-1}(x_i)$
$i = N?$
NO
$i+1 \rightarrow i$
YES
$u_{m+1} = \frac{②}{①} \rightarrow u_m$; $V_m = \frac{③}{D_{m-1}} \rightarrow V_{m-1}$;
$a_m = \frac{④}{①}$; $① \rightarrow D_{m-1}$
$i = 0$
$-a_m P_m(x_i) + y_i - \sum_{j=0}^{m-1} a_j P_j(x_i) = \epsilon_m(x_i)$
$i = N?$
NO
$i+1 \rightarrow i$
YES
OUTPUT: $C_m^K = \sum_{j=K}^{m} a_j b_K^j$, $K = 0, 1, \cdots, m$
Compute
b_K^{m+1} , $K = 0, 1, \ldots, m$
$m+1 \rightarrow m$
NO
$m = M?$
YES, END PROGRAM

FIG. 1

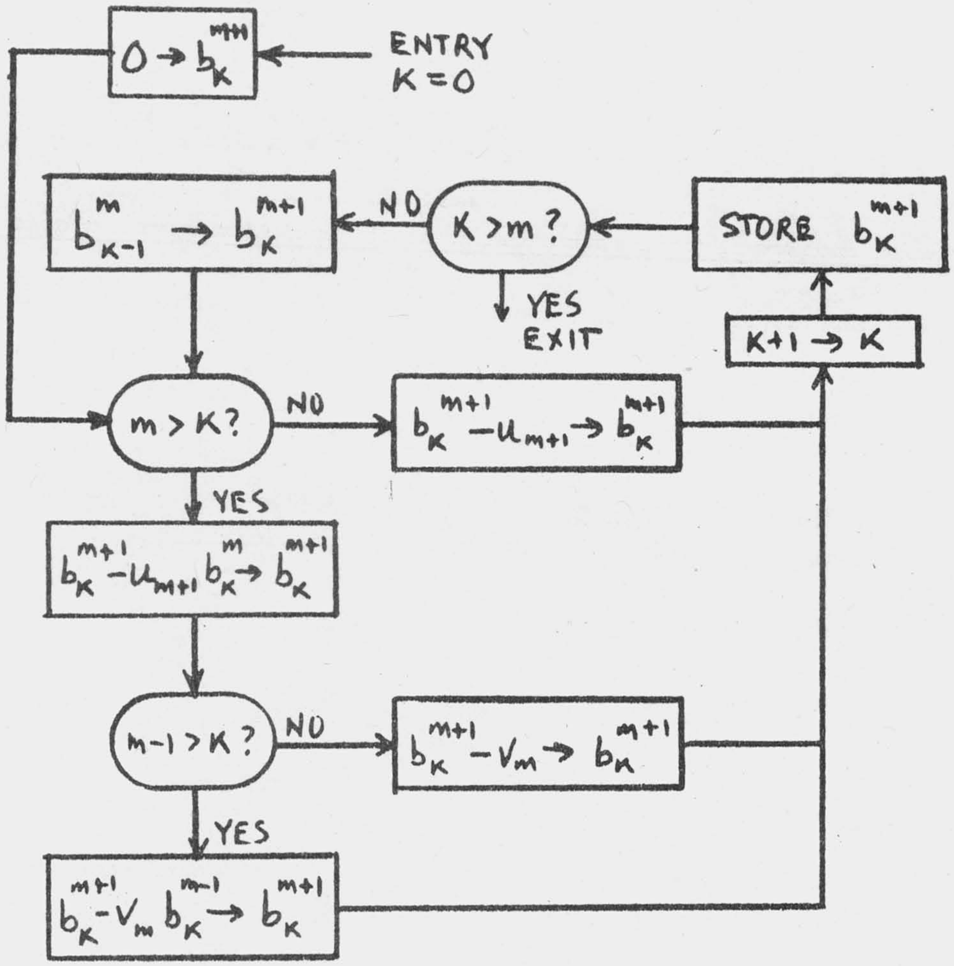


FIG. 2
COMPUTATION OF
b_K^{m+1}; $K=0,1,\ldots,m$

REFERENCES

1. Householder, <u>Principles of Numerical Analysis</u>, McGraw-Hill, 1953.

2. E. Stiefel, "Kernel Polynomials and Their Numerical Applications," Multilithed Lecture Notes, American University, 1955.

3. G. Forsythe, Notes for "Seminar on Computational Aspects of Linear Problems," University of California at Los Angeles, Spring Semester, 1956.

4. Milne, <u>Numerical Calculus</u>, Princeton, 1949.

April 10, 1957

Dr. R. P. Rich
Applied Physics Laboratory
Johns Hopkins University
8621 Georgia Avenue
Silver Spring, Maryland

Dear Dr. Rich:

I would like to propose two items for the Agenda of the next USE meeting.

Proposal No. 1 - "A double precision, floating point number in standard, packed form shall occupy two consecutive cells. The first cell shall contain a standard single precision floating point number consisting of a sign bit, an eight bit biased exponent, and the twenty-seven most significant bits of the mantissa. The second cell shall contain thirty-six additional bits of the mantissa.

Proposal No. 2 - "The USE Compiler language shall be expanded to include an additional class of instruction type lines of coding to facilitate the use of the IP (14) instruction. These will be identified by the occurrence in OP Field of certain symbols which are different from all other compiler language operations and from the names of all subroutines.

Each of these new operations will be translated into 14 operations. The v address field will be translated as in ordinary instructions. The u address field will be translated in the ordinary way and then taken modulo 2^9. A warning will be given if $(u) \neq (u) \bmod 2^9$. Finally, a six-bit code corresponding to the particular operation used will be placed in the high order part of u".

Comments on Proposal No. 1 - We have made a comparative study of the following schemes for floating point, double precision numbers:

1.	1	8 C	27 M_1	36 M_2

2.	1	8 C_1	27 M_1	1	8 C_2	27 M_2

$C_1 - C_2 = 27.$ Sign agreement

3.	1	8 C	27 M_1	1	35 M_2

Sign agreement

4.	1	35 M_1	1	27 M_2	8 C

Sign agreement

On the basis of our study, which included actual coding and comparison of times, we have concluded that Scheme No. 1 is the most desirable. Representatives from Lockheed have concurred in this choice.

Comments on Proposal No. 2 - The proposed new instruction type is intended to facilitate the use of the IP instruction with interpretive packages for floating point, double precision, complex, and/or matrix arithmetics. It will work well with single adress schemes such as Lockheed's FAP in which the address is written in the v field, usually as a tag, and the right three octal digits of the u field are written in octal and may be used to indicate such things as B-boxes, result storage, breakpoint levels, etc.

The choice of mnemonic OP codes and their six-bit equivalents has not yet been made. One suggestion is to begin each OP code with the letter I (interpret) and use IADD, ISUB, IMPY, IDIV, etc. A typical line of coding in the FAP system then might be as follows:

```
, , IADD , 720)B , ALPHA , $
```

indicating breakpoint level seven, result storage two, and no index register. If the octal code for IADD were 01 and if the Tag Alpha had been assigned to cell 100 decimal this line of coding would be translated into:

```
14 01720 00144
```

other interpretive schemes might make different use of the octal digits in the u field. Ramo-Wooldridge has agreed to make the necessary changes in the compiler to handle the new type of instruction. This will not delay completion of the compiler as originally specified.

One suggested procedure for incorporating interpretive packages in a USE Compiler system is to write the entire package as a standard USE Subroutine requiring no parameters. Symbolically such a subroutine might begin as follows:

ITEM NUMBER	TAG	OPERATION	U ADDRESS	V ADDRESS	COMMENTS	
,	,	SUB ,	MATRIX ,	n ,	FIRST THREE	$
,	,	INOUT ,	0 ,	r ,	LINES USED BY	$
,	,	TEMPS ,	t ,	0 ,	COMPILER.	$
,	ENTER ,	MJ ,	0 ,	SETUP ,	ENTER HERE VIA	$
,	ERROR ,	ALARM ,	0 ,	0 ,	CALLING SEQUENCE	$
,	EXIT ,	MJ ,	0 ,	FILL ,	TO ACTIVATE	$
,	RESULT,	RESERV ,	r ,	r ,	PSEUDO ACCUMULATOR, ETC.	$
,	SETUP ,	TP ,	DUMMY ,	1 ,	SET UP JUMP	$
,	,	MJ ,	0 ,	EXIT ,	IN CELL F2.	$
,	DUMMY ,	MJ ,	0 ,	INTERP ,	DUMMP FOR F2	$
,	INTERP,	,	,	,	ENTER HERE VIA	$
,	,	,	,	,	F2 TO INTERPRET	$

To "activate" the package the programmer would write, for example:

, , MATRIX , , , $

This would cause the compiler to include the package in the compiled region and, at execution time, the return jump generated by this line would transfer control to the normal entry of the subroutine. Cell F_2 (=00001) would be set up and control returned to the main program. Subsequent interpret instructions would cause control to go to F_2 and then to the interpret part of the subroutine. The cells reserved for "RESULTS" could be the pseudo accumulator, B-Boxes, or whatever else would be useful in case of an alarm exit. This scheme permits the inclusion of two or more interpretive routines in the same program.

Very truly yours,

THE RAMO-WOOLDRIDGE CORPORATION

Robert Perkins
Member of the Technical Staff
Computer Systems Division

RP:ml

CC: W. E. McVicar
(for distribution to
USE members)

Talmadge

TENTATIVE AGENDA FOR SEATTLE MEETING

Policy Committee

New Members
Approval of Minutes
Set Agenda
Action on Committee Reports of last meeting
Los Angeles Meeting on Information Exchange
Free Time for USE
Revised Statement of Policy
Action on Committee Reports of this meeting
Time and Place of Next meeting
Bull Letter
Request Report on 301-G
Status of Programming Manual
Request report on double drum
Request report on improved Uniservos

General Session

Announcement of Agenda
Boeing Data Reduction System (Mr. Jack Janholm)
Univac File Computer (Mr. Les Knutson)
Visit to Boeing Data Reduction Center (Fri. P.M.)
Salmon Barbecue Thursday evening

Installation Operations Committee

Minimum USE machine
Acceptance Tests and Performance Standards
Experience with Bull
Action on Machine Modifications
Data Conversion Equipment (Boeing, Holloman, Ramo-Wooldridge)

Program Development Committee

Status of Print Edit Routine
Status of USE Compiler
Other Coding Assignments

Mathematics Committee

Welcome by Dr. Gaskell
Eigenvalues and Eigenvectors
Status of previous assignments

Talmadge

Minutes of the USE Policy Committee

24-26 July 1957, Seattle

The Policy Committee was called to order at 9:15 A.M., 24 July. Those present were:

R. P. Rich (AP) Chairman
W. E. McVicar (RR) Executive Secretary
T. Dewey (ML)
R. G. Tantzen (HO)
D. Zonars (WF)
D. H. Heiser (BC)
G. Clark (OR)
A. Stone (AP)
D. Combelic (RW)
D. Cook (BA)
R. D. Schmidt (RR).

The Corps of Engineers was not represented.

Item 1: New Voting Members.

There were no new voting members since the last meeting.

Item 2: Approval of Minutes.

It was moved by Heiser and seconded by Dewey that the minutes of the preceding meeting be approved. Carried unanimously.

Item 3: Agenda.

The final agenda for the meeting is given as Appendix 1.

In order to make use of Friday afternoon it was decided to have a general discussion moderated by Tom Wilder during the Policy Committee meeting and an unmoderated general discussion following the summary general session. A visit to Boeing was also scheduled during the Policy Committee Meeting.

Item 4: Action on Machine Modifications.

It will be recalled that, in addition to certain machine modifications to be made without charge, Remington Rand offered the following five machine modifications at prices contingent upon acceptance by all users:

1) Additional Uniservo indicator lights
2) Addition of computer stop bell
3) Modification of overflow stop
4) Abnormal to Normal drum instruction
5) Two interchange instructions.

It was moved by Clark and seconded by Combelic that none of these five modifications was of interest to USE at the prices quoted. The motion carried with 8 ayes and one nay.

It was moved by Dewey and seconded by Clark that: In view of the fact that USE considers the modification of the overflow stop to be so desirable, it is requested that Remington Rand reconsider the price of this modification, and that this modification be made standard on future machines. Motion carried.

Item 5. Actions on Committee Reports of Last Meeting.

The only committee recommendation not acted upon at the last meeting was that concerning cataloging of USE subroutines, made by the Program Development Committee.

It was moved by Dewey and seconded by Stone that the Program Development Committee's recommendation on cataloging made at the April meeting not be approved. The motion was carried unanimously and the question was returned to the Program Development Committee for reconsideration.

Item 6: Revised Statement of Policies.

It was moved by Dewey and seconded by Cook that the "Revised Statement of Policies approved 24 July 1957" (Appendix 3 of these minutes) be adopted by USE. Motion carried unanimously.

Item 7: Action on Bull Letter.

At the Policy Committee meeting in April, a letter on the Bull Reproducer was approved for submission to member organizations for signature and transmittal to RR-Sales.

Mr. Aamoth of RR-Sales sent a letter dated 1 May to all member organizations listing the actions to be taken by Remington Rand to overcome the deficiencies of this equipment.

B. C. Dove (ML) requested a mail vote by the Policy Committee on suspending transmittal of the Bull letter to Remington Rand. This request was by telegram dated 7 May. The mail vote was taken; there were 8 in favor of suspension and one opposed. The matter was therefore deferred to the present meeting for final action.

It was moved by Cook and seconded by Clark that the motion at the last meeting to send the Bull letter be rescinded. Motion carried unanimously.

Bob Schmidt reported on progress made in meeting the Bull difficulties. Harvey Devries is now Bull liaison man for Remington Rand; his services are available to any installation as required. The time allowed for the Bull training course and for on-the-job training has been increased. A new set of maintenance tests for the whole machine is being written. A survey of Bull performance at various installations has been carried out.

Item 8: Los Angeles Meeting on Information Exchange.

In a letter dated 12 April 1957, Dr. Walter A. Bauer invited a number of people to a meeting at Ramo-Wooldridge on 9-10 May 1957 to consider the problem of information exchange among computer users on a broader basis than that afforded by organizations of users of specific machines. One result of this meeting was an open letter to the Association for Computing Machinery, reproduced as Appendix 2 of these minutes.

In the Policy Committee discussion of this item it appeared that the A. C. M. did not take very positive action at the Houston meeting and that progress in the field of a metamachine language would depend upon the user's organizations. Don Combelic reported that plans are already underway to translate Alan Perlis' IT compiler for the 704 and 1103A, in addition to the 650 and Datatron. The relevance of Fortran and Unicode to this problem were discussed. It was felt that further thought and discussion would be required before a specific course of action for USE could wisely be recommended.

(Note: Herb Bright, Secretary of SHARE, indicated that this question would be discussed at the SHARE executive meeting the last week in July, and that the results of this discussion would be made available to the USE chairman for distribution to the Policy Committee.)

Item 9: Free Time for USE.

An additional 10 hours of machine time has been contributed to USE by Remington Rand. 8.9 hours of this was used by Wright Field on APL's machine to debug the Print-Edit routine. This brings Remington Rand's total contribution of free time to 70 hours, of which 10.1 hours still remain unused.

Item 10: Next Meeting.

The next USE meeting will be at Dallas on 20-22 November 1957 (or 13-15 November if Thanksgiving is the 21st).

Item 11: Status of Programming Manual.

The first two sections are being prepared for the printer, the third section for initial distribution this fall. Distribution of the completed manual is planned for January of 1958.

The Policy Committee expressed concern over the long delay in production of the manual, and emphasized the importance of meeting the new date.

Item 12: Double Drum and Improved Uniservos.

Bob Schmidt reported that the present drum has room for 32,000 words and space provided for the additional heads. The main change required in going to the double drum is the circuitry necessary to switch from one half to the other by an external function instruction. Price of this modification will be available from local sales representatives within a month.

A firm decision on the details of the improved Uniservo has not yet been made.

Item 13. Timeliness of Committee Reports.

Committee chairmen were urged to avoid unnecessary delay in circulating their reports.

Item 14: Non-Voting Members.

By mail vote since the last meeting, Litton Industries was admitted to non-voting membership in USE. The voting on Arnold Engineering Development Center (ARO) and the Bureau of Internal Revenue has not yet been completed. Previously admitted were: Shell Development Corp., National Security Agency, National Bureau of Standards, and California Texas Oil Co.

Item 15: Action on Committee Reports of this meeting.

a) Mathematics Committee: no action necessary.

b) Installation Operations Committee. This committee made three recommendations:

1. That the Program Development Committee investigate a framework within which a set of machine reliability checking programs can be written and distributed through USE such that reliability checks can be made in the normal course of computation at the option of the machine operator.

2. That the Univac Card Equipment, in view of its satisfactory performance at this time, be dropped from future agendas until such time as conditions warrant its reappearance.

3. That individual installations report at each meeting the following machine efficiencies:

$$\text{Efficiency C} = \frac{\text{Available time - all lost time}}{\text{Available time}}$$

$$\text{Efficiency D} = \frac{\text{Available time - all lost time}}{\text{Scheduled time}}$$

$$\text{Efficiency E} = \frac{\text{Available time - all lost time}}{\text{Scheduled time + Preventive Maintenance}}$$

where:

available time is that time during which the computer is up and turned over to the customer.

Scheduled time is that time during which the customer plans to operate the machine.

Preventive Maintenance is any maintenance done outside of the scheduled time.

All lost time consists of two parts:

1. Lost time is that time which produces bad or no results due to machine malfunction.

2. Other lost time is that time which produces bad or no results for any other reason. (In particular facility failure - i.e. power, water, etc. - is included in OLT.)

Recommendations (1) and (3) were unanimously approved by the Policy Committee. Recommendation (2) was not approved.

It was moved by Combelic and seconded by Dewey that the Policy Committee recommends Remington Rand for its positive and effective action on the Bull. The motion was passed.

c) <u>Program Development Committee</u>. This committee made three recommendations:

1. That the list of IP codes proposed by the RW-LM subcommittee on this subject be adopted as standard.

2. That alarm exits in USE subroutines put the flex-coded name of the subroutine in Q and a Return jump instruction in the exit cell.

3. That, in order to provide a list of distributed USE programs in convenient form for reference, Remington Rand maintain a current list of these arranged in accordance with the Catalog System described by Appendix E in the Report of the Program Development Committee dated 25-26 April 1957. That the tags used to identify USE programs be assigned by the originating organization. And that the Executive Secretary circulate revised lists at intervals to be determined by himself.

All three of these recommendations were unanimously approved by the Policy Committee.

<u>Item 16</u>: Billing Policy.

This subject was discussed briefly.

Respectfully submitted,

R P Rich

R. P. Rich, Chairman

APPENDIX 1: AGENDA.

A. Policy Committee.

1. New Non-Voting Members
2. Approval of Minutes
3. Set agenda
4. Action on machine modifications
5. Action on committee reports of last meeting
6. Revised Statement of Policy
7. Action on Bull letter
8. Los Angeles meeting on information exchange
9. Free time for USE
10. Time and place of next meeting
11. Status of Programming Manual
12. Report on double drum and improved Uniservos
13. Timeliness of Committee Reports
14. Non-Voting Members
15. Action on Committee Reports of this meeting
16. Remington Rand billing policy

B. General Session.

1. Announcements
2. Boeing Data Reduction System (Jack Granholm)
3. Univac File Computer (Les Knutson)
4. Status of Tape Verifier (Bob Schmidt)
5. Boeing Printer-Plotter (Don Cook)
6. Los Angeles meeting on Information Exchange
7. Status of Programming Manual (Dick Terry)
8. Reports of Committee chairmen

C. Installation Operations Committee.

1. Minimum USE machine
2. Confidence tests and performance standards
3. Experience with the Bull
4. Data Conversion Equipment
5. Experience with tape units

D. Program Development Committee.

1. Status of Print Edit Routine
2. Status of USE compiler
3. Review of coding assignments
4. Standard subroutine write-up
5. Unicode status report
6. Tape programming

E. Mathematics Committee.

1. Welcome by Dr. Gaskell
2. Eigenvalues and Eigenvectors
3. Review of previous assignments
   (A detailed agenda for this committee will be found in its report).

APPENDIX 2

Los Angeles
May 10, 1957

We, as users of diverse machines, recognizing that developments in the use of automatic computers are leading to techniques of programming which transcend the characteristics of particular machines, that communication between users of different machines is highly desirable, and further, that completed programs which are machine independent appear to be possible, recommend that the ACM take the following action:

a) Appoint a committee to study and recommend action toward a universal programming language.
b) Set up means for the rapid exchange of practical information on computer programs and programming among all computer users.
c) Appoint a committee to study and recommend areas of standardization.
d) Appoint a committee to propose means by which the ACM can foster developments in programming research.

We further recommend that the several computer users organizations engage in a joint effort in support of these objectives.

Paul Armer, The RAND Corporation
Walter F. Bauer, The Ramo-Wooldridge Corporation
John W. Carr, III, University of Michigan
Frank Engel, Jr., Westinghouse Electric Corporation
Donald W. Gantner, The Ramo-Wooldridge Corporation
Edward M. McCormick, U. S. Naval Ordnance Laboratories
Alan J. Perlis, Carnegie Institute of Technology
Randall Porter, Boeing Airplane Company
Walter Ramshaw, United Aircraft Corporation
Robert P. Rich, The Johns Hopkins University
Jack A. Strong, North American Aviation
Richard B. Talmadge, Lockheed Aircraft Corporation

APPENDIX 3

Revised Statement of USE Policies

Approved 24 July 1957

1. Name.

This organization shall be known as the Univac Scientific Exchange (USE).

2. Purpose.

The primary purpose of this organization shall be the promulgation and exchange of ideas and information concerning programming and operation of the 1103A, and the establishment of a forum wherein 1103A users and representatives of the Remington Rand Univac Division can discuss suggestions for machine development and additional equipment to their mutual benefit.

3. Membership.

Membership in USE is voluntary and by organization. Members are comprised of two groups: voting members and non-voting members.

3.1. Voting Members. An organization becomes a voting member upon presentation to the Executive Secretary of: (a) Application for membership and (b) Evidence that the organization is or will be in both operational and scheduling control of one or more 1103A computers. Not more than one voting membership shall be accorded one 1103A computer.

3.2. Non-Voting Members. An organization desiring non-voting member status must submit a request to the Executive Secretary of USE. Upon receipt of such a request, the Executive Secretary will submit the organization's name to the membership for vote, either by mail or in a regularly scheduled meeting. If the vote is taken at a meeting, a majority of the total membership shall be sufficient to admit an organization to non-voting member status. If the vote is taken by mail, the provisions of Section 9.8 shall apply.

4. Visitors.

Visitors may be invited to attend USE meetings by any voting member organization or by the Remington Rand Univac Scientific Sales Department, St. Paul, Minnesota (hereinafter called RR-Sales). The number of invitees and, if possible, their names and organizational affiliation must be submitted to the chairman and RR-Sales prior to the meeting which they are to attend.

5. Officers.

The officers of USE shall consist of a Chairman and an Executive Secretary. Each must be a member of a voting member organization. Each is elected by a majority vote of the Policy Committee for a term of one year beginning 1st April.

6. Chairman.

6.1. The Chairman will officiate at all general sessions of USE meetings. He will be responsible for the preparation of a tentative agenda for each meeting of USE and will submit it to the Executive Secretary for reproduction and distribution to the membership before the meeting.

6.2. The Chairman will also serve as chairman of the Policy Committee and will be a member ex officio of all other USE committees.

6.3. The chairman or the Policy Committee may appoint a chairman pro tem at any time.

6.4. The retiring chairman will be a non-voting member of the Policy Committee for a period of one year after leaving office unless, at the option of his organization, he becomes the regular representative of his organization during that same period.

7. Executive Secretary.

7.1. The Executive Secretary will reproduce and distribute the minutes of meetings, committee reports, the tentative agenda for USE meetings, reports of USE routines, Useful Notes, and such other items as the Policy Committee may direct.

7.2. He will process applications for membership in accord with Section 3 and requests for attendance at meetings in accord with Section 4.

7.3. He will be a non-voting member of the Policy Committee and will provide at each meeting a complete reference file of official USE records and correspondence.

7.4. He will serve as Chairman of the Publications committee and in that capacity may refuse to distribute through USE channels anything which does not meet the standards set up by USE.

7.5. In this capacity he shall make available to RR-Sales, to use as they see fit: Membership lists of the USE organization; specifications and descriptions of routines which are available to members of USE; and such other items as the Policy Committee may from time to time direct.

8. Meetings.

8.1. Meetings of USE will be held at the discretion of the Policy Committee. RR-Sales will serve as host for all meetings and will be responsible (1) for arranging committee meeting assembly facilities, (2) for alerting hotel facilities for reservations, and (3) for providing such other services as they deem necessary or desirable in order to facilitate the course of the meetings.

8.2. Each organization will be responsible for submitting the number and, when possible, the names of its representatives to RR-Sales prior to each meeting.

9. Policy Committee.

9.1. The governing body of USE is the Policy Committee. It consists of one representative from each voting member organization, the chairman of USE as non-voting chairman, and other non-voting members as specified in Sections 6.4 and 7.3.

9.2. It is the responsibility of the Policy Committee to guide the activities of USE into productive channels. All authority for decision in USE matters resides in the Policy Committee unless explicitly delegated by that body.

9.3. Meetings of the Policy Committee will normally be closed, except that by a vote of the committee particular sessions may be open to the public or to specified individuals.

9.4. The Policy Committee will determine the final agenda for each meeting and assign items to committees. It will consider all committee recommendations and decide on the action to be taken.

9.5. The Policy Committee will neet at each general USE meeting, and may meet at other times at its discretion.

9.6. A quorum of the Policy Committee will consist of at least 60% of the voting membership.

9.7. At least 2/3 "yes" and no more than 1/4"no" of the quorum shall be required to pass a motion in the Policy Committee except that election of officers is by majority vote, as specified in Section 5.

9.8. Mail voting.

Voting may be by mail in the circumstances described below. The provisions of 9.7 shall apply in each case.

a) New Business. A mail vote on new business may be requested at any time by any member of the Policy Committee via the Executive Secretary. Quorum is 100% of voting membership.

b) Uncompleted Business. At the discretion of the Policy Committee a vote on a motion made in session may be deferred to a mail vote. The vote is to be conducted by the Executive Secretary within a time limit established by the Policy Committee at the time of the deferral. Such ballots are to be counted on the first working day after the deadline and a quorum consists of the votes received by that time. Prior to the vote the Executive Secretary shall poll all members by mail.

c) Reconsideration of Previous Action. Upon request of at least one-third of the Policy Committee, the Executive Secretary shall poll the membership on any question acted upon previously. A quorum shall consist of those votes received within one month of the date of the poll; the deadline date shall be explicitly stated in the polling letter.

10. Committees.

10.1. The Policy Committee may form and disband working committees as the need arises. Such committees will consider any agenda items assigned to them as described in Section 9.4. and may at the discretion of the committee chairman consider other items in the same general field.

10.2. Each chairman of an active committee will make an oral report to the general USE meeting which will outline the subjects discussed and will contain the recommendations of the committee.

10.3. Each chairman will also submit a written report to the Executive Secretary within a reasonable time after the meeting for distribution to the members of USE. Upon receipt of the written report of the chairman, anyone who feels that it is incomplete or erroneous may communicate directly with the committee chairman, who may then submit an amended report to the membership at the next meeting.

10.4. These committees will normally meet concurrently with the general USE meeting. The chairman of a committee may call a meeting at any time providing that at least two weeks notice is given to each committee member for each meeting that is not held during a general USE meeting.

10.5. Meetings of these committees will normally be open, and invited guests may participate by direction of the chairman. Conduct of committee meetings is at the discretion of the chairman.

10.6. Terms of committee chairmen will end on the 31st of March following appointment. A committee chairman may be reappointed.

11. Standing Committees.

There are at present four standing committees: The Program Development Committee, the Publications Committee, the Mathematics Committee, and the Installation Operations Committee.

11.1. Program Development Committee. The function of the Program Development Committee is to exchange programming ideas, information, and techniques, and to avoid duplication of effort where possible by voluntary cooperation in programming work.

11.2. Publications Committee. The Executive Secretary of USE is chairman of this committee. The function of the Publications Committee is to set up and maintain proper standards of communication between member organizations through USE channels. Each organization will have a member of the Publications Committee, who will be responsible for seeing that any material submitted to USE from his organization meets the relevant standards, and for distributing throughout his organization the material distributed through USE.

11.3. Mathematics Committee. The functions of the Mathematics Committee are: 1) exchange of working codes for mathematical subroutines; 2) description of working experience with existing mathematical subroutines; 3) discussion of promising mathematical methods with the idea of developing subroutines using these methods; 4) preparation of specifications for mathematical subroutines and recommendation of a member organization to provide a working machine program in standard USE language to be distributed through regular USE channels.

The Committee will have a general subject for each meeting chosen by the Policy Committee, usually upon recommendation of the Mathematics Committee.

11.4. Installation Operations Committee. The function of the Installation Operations Committee is: 1) to consider questions concerning the operation and maintenance of an 1103A installation, 2) to exchange information on operating experience, and 3) to consider machine modifications.

Proceedings of the Mathematics Committee of the USE Organization

July 25-26, 1957 Seattle, Washington

The Mathematics Committee met during the regular session of the USE organization at the Benjamin Franklin Hotel, Seattle, Washington under the chairmanship of Dr. James Ward, Holloman Air Force Base. The agenda for the session is given in Appendix A. Over 23 persons participated during the course of the meeting representing 8 organizations. (Appendix B)

Thursday, July 25, 1957

The committee went into session in the afternoon and began its proceedings with an address of welcome by Dr. R. E. Gaskell, Boeing Airplane Co., on the "Practice of Mathematics". This talk was previously given in another form to the Association for Computing Machinery.

Following these remarks Werner L. Frank described the research activities performed at The Ramo-Wooldridge Corporation in finding eigenvalues and eigenvectors of complex non-Hermitian matrices. A number of subroutines were described which already are or will be made available to USE. As requested by the committee, most of these remarks are appended to this report in the form of a paper which was delivered at the symposium on "Computing in the Aircraft Industry" at New York University, January, 1957 (Appendix C).

Concluding the afternoon session was the paper given by Dr. Paul T. Mielke, Boeing Airplane Co. The eigenvalue problem, as it applies to flutter stability analysis was discussed. (Appendix D.)

Friday, July 26, 1957

Mr. L. R. Turner, National Advisory Committee for Aeronautics began the morning proceedings with a discussion of the matrix eigenvalue problem as it occurs in nuclear reactor calculations. Two papers were distributed (1 and 2 of Appendix E).

Concluding the prepared presentation was B. Rudin, Lockheed Missiles, who described a relatively unknown method of finding the characteristic equation due to J. G. Bryan and described in his Harvard dissertation "A Method for the Exact Determination of the Characteristic Equation". Mr. Rudin indicated his interest in programming this method. (Appendix F)

A discussion followed to formalize our thoughts and to make a report to the Policy Committee. Such report is contained in Appendix G.

A status report of the autocorrelation-spectral density routine was distributed as noted in Item 3 of Appendix E.

For the convenience of those not present, Appendix E lists all items which were distributed. Some of these reports are included as appendices if vellums were supplied by the authors.

Submitted by

James A. Ward, Holloman Air Force Base

Werner L. Frank, The Ramo-Wooldridge Corp.

Correction of the Proceedings of the Mathematics Committee, April 25-26, 1957

Replace lines (25) to (31) by:

(1) Routines should incorporate special formulas for special cases and one should have several general subroutines such as: 4^{th} order Runge-Kutta, Adams-Moulton, Milne Method.

(2) The integral equation approach is recommended whenever possible.

Appendix A

USE ORGANIZATION

AGENDA OF MEETING OF MATHEMATICS COMMITTEE

Host Organization: Boeing Airplane Company

Seattle, Washington

July 25-26, 1957

Theme: Eigenvalues and Eigenvectors of Matrices

Chairman: Dr. James Ward, Holloman Air Force Base

Thursday, July 25, 1957

1. General USE Session

2. Address of Welcome to Mathematics Committee
   "The Practice of Mathematics"
   Dr. R. E. Gaskell, Boeing Airplane Company

3. Numerical Experiments in Finding Eigenvalues and Eigenvectors of Arbitrary Matrices at The Ramo-Wooldridge Corporation.
   Werner L. Frank, The Ramo-Wooldridge Corporation.

4. Experiments with Finding Eigenvalues of Matrices for Flutter Stability Analysis
   Dr. Paul T. Mielke, Boeing Airplane Co.

Friday, July 26, 1957

1. Eigenvalues of Matrices
   L. R. Turner, National Advisory Committee for Aeronautics

2. Eigenvalues of Matrices
   Bernard Rudin, Lockheed

3. Preparation of Report to Policy Committee

4. Status Report

   a. Autocorrelation and Spectral Density Routine

   b. Ordinary Differential Equation Experiments

5. General USE Session

Appendix B

Attendance at Mathematics Committee

Boeing Airplane Company	R. E. Gaskell J. F. Price J. D. Wheelock P. T. Mielke G. Marsaglia F. Magness J. Fugher J. B. Butler W. Howland D. Weilan K. McKinley
White Sands Proving Ground	R. Bigelow
The Ramo-Wooldridge Corporation	W. L. Frank
Remington Rand Univac	R. A. Zemlin B. Mittman R. Simon O. E. Tanthu George Etsell B. Gerkin
Stanford Research Institute	R. H. Spencer
Lockheed Missiles	B. D. Rudin
Holloman Air Force Base	J. A. Ward
Applied Physics Laboratory	R. P. Rich

Eigenvalue Problems in Modern Industry II: Computing Techniques for Matrices

by

Werner L. Frank and Ivin Tarnove

The Ramo-Wooldridge Corporation

INTRODUCTION

The algebraic eigenvalue problem has received considerable attention in many areas of modern industry with special emphasis in the aircraft field. Numerous mathematical methods have been proposed for finding eigenvalues, most of which are satisfactory for low order matrices. However, as the need to handle higher order matrices arose, one is faced with limitations of speed, word length, and storage capacity of modern digital computers. It is, therefore, essential to determine those methods which offer the greatest possibility of efficient handling of higher order matrices.

Motivated mainly by problems in the stability of fluid flow [19] and in the stability of control systems, The Ramo-Wooldridge Corporation embarked upon an investigation designed to produce practical routines for finding eigenvalues of arbitrary matrices of orders about 20.

For this purpose codes were written for the Univac Scientific Computer Model 1103 based on several mathematical methods, so that the characteristics of each could be compared and in order to obtain a basis of selection of routines for specific problems. The mathematical methods will be presented and the numerical results discussed.

First, by way of definition, λ is an eigenvalue of the matrix A if and only if there exists a non-zero vector x such that $Ax = \lambda x$. The non-zero vectors which satisfy this equation for a given eigenvalue are the eigenvectors of A corresponding to the eigenvalue λ.

The several mathematical methods to be presented are all based on three principles. These are as follows:

NN-44
From: W. Frank and
I. Tarnove
Date: Feb. 22, 1957

Eigenvalue Problems in Modern Industry II: Computing Techniques for Matrices

by

Werner L. Frank and Ivin Tarnove

a) Root Finding Techniques:

The matrix equation $Ax = \lambda x$ is a homogeneous system of linear algebraic equations which can be written $(\lambda I - A)x = 0$. Such a system can have a non-trivial solution only if the determinant $|\lambda I - A|$ vanishes. Thus the eigenvalues may be characterized as the values of λ for which $|\lambda I - A| = 0$. The determinant is a polynomial $p(\lambda)$ of n^{th} degree in λ where n is the order of A. This polynomial is called the characteristic polynomial and the equation $p(\lambda) = 0$ is called the characteristic equation. A method which obtains the eigenvalues as roots of $p(\lambda)$ or a related function will be called a root finding technique.

b) Power Method:

The sequence of vectors defined recursively by

$$y_{i+1} = c_{i+1} Ay_i$$

where y_o is arbitrary and the c's are normalizing factors tends, in general, toward an eigenvector corresponding to the eigenvalue of A of maximum modulus. Suppose the eigenvectors $x_1, x_2, \ldots, x_n$ of A form a basis for the vector space. Then any vector y_o may be represented as

$$y_o = \alpha_1 x_1 + \alpha_2 x_2 + \ldots + \alpha_n x_n$$

and after k iterations, y_k will be parallel to the vector

$$\alpha_1 \lambda_1^k x_1 + \alpha_2 \lambda_2^k x_2 + \ldots + \alpha_n \lambda_n^k x_n .$$

If $|\lambda_1| > |\lambda_i|$ $(i = 2, \ldots, n)$ then for sufficiently large k

$$|\alpha_1 \lambda_1^k| >> |\alpha_i \lambda_i^k| \quad (i = 2, \ldots, n)$$

and y_k will then be essentially parallel to the eigenvector x_1 corresponding to the dominant eigenvalue. If λ_1 is a multiple eigenvalue the same result applies. However, if there is more than one eigenvalue of maximum modulus it is necessary to employ special devices in addition to the basic iteration [10].

c) Use of Similarity Transformations:

The matrix B is similar to A if and only if there exists a matrix S such that

$$B = S^{-1} A S$$

The matrix B is said to be the result of a similarity transformation on A. The importance of similarity transformations in the quest for eigenvalues lies in the fact that similar matrices have the same eigenvalues. For

$$\begin{aligned} |B - \lambda I| &= |S^{-1} A S - \lambda I| = |S^{-1} (A - \lambda I) S| \\ &= |S^{-1}| |A - \lambda I| |S| = |A - \lambda I| . \end{aligned}$$

The aim is to determine a matrix S so that the similarity transformation of A results in a matrix B whose eigenvalues are more easily found, usually by a root finding technique or so that the eigenvalues are explicitly exhibited in the matrix B. An application of this principle to real symmetric matrices is the Jacobi Rotation Method [14, 16] which produces a diagonal matrix B similar to A. The eigenvalues of A are then read off as the diagonal elements of B and the eigenvectors are the columns of the orthogonal matrix S. A routine carrying out this procedure has been written at The Ramo-Wooldridge Corporation [23]. A modification of the Jacobi method is due to W. Givens [15] which produces a tridiagonal matrix similar to A. As these methods apply only to real symmetric matrices they will not be discussed further. Generalization of the Jacobi method for arbitrary complex matrices have been proposed by J. Greenstadt [17] and also by J. vonNeuman* and M. Lotkin [18]. These produce a triangular matrix B similar to A from which the eigenvalues again can be read off as the diagonal elements. These methods are currently under investigation at The Ramo-Wooldridge Corporation, with results to be presented in a forthcoming paper.

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* See discussion in Reference 17.

MATHEMATICAL METHODS

1. Determinant Evaluation:

A root finding routine [22] in use at The Ramo-Wooldridge Corporation requires only the value of the function at arbitrary points. Applied to the function $|\lambda I - A|$ the eigenvalues of A are obtained. This process requires the evaluation of a determinant of order N for each iteration and consequently the computing time becomes prohibitive for large N. However, the accuracy of the eigenvalues is quite good.

2. Danilewski:

This is a method of reducing an arbitrary matrix by a similarity transformation to a form displaying the coefficients of the characteristic polynomial [7, 20] . This form usually turns out to be the companion matrix

$$\begin{bmatrix} 0 & & & & & -c_n \\ 1 & 0 & & 0 & & -c_{n-1} \\ & 1 & \cdot & & & \cdot \\ & & & \cdot & & \cdot \\ & & & & \cdot & \cdot \\ & 0 & & & 0 & -c_2 \\ & & & & 1 & -c_1 \end{bmatrix}$$

from which one can write the characteristic polynomial as

$$p(\lambda) = \lambda^n + c_1\lambda^{n-1} + \dots + c_n \ .$$

In certain cases the characteristic polynomial will appear in factored form. The similarity transformation is a product of elementary similarity transformation of the following types:

a) interchange of i^{th} and j^{th} rows and j^{th} and i^{th} columns
b) multiplication of i^{th} row by a constant and division of i^{th} column by the same constant
c) add to the i^{th} row a multiple of j^{th} row and subtract from j^{th} column the same multiple of the i^{th} column.

This method is quite fast but rather inaccurate. The inaccuracy can be traced to the round-off errors incurred in obtaining the coefficients of $p(\lambda)$ whose roots, the eigenvalues of A, are very sensitive to slight variations in the coefficients. In anticipation of this situation the routine employing this method provides an option for performing the similarity transformation with either single or double register number representation. Figures 3 and 4 indicate the degree of improvement in accuracy obtained by the added precision.

Of the two methods discussed one is slow and accurate, the other fast but inaccurate. The next method affects an improvement in speed, while maintaining good accuracy at a severe price, since it is necessary to have very good estimates of the eigenvalues.

3. Leppert's Method:

This method makes use of a rational function whose roots are the eigenvalues of **A** [5]. Codes based on this procedure were first written at Lockheed, Burbank, for use on the CPC and later developed for the 701 and now for the 704 [6]. Convair, San Diego, [21] adopted this code for the 1103, and applies to matrices up to order 10.

The method is based on the fact that a polynomial of degree n is completely determined by its values at n+1 distinct points. Let $\lambda_o, \lambda_1, \ldots, \lambda_n$ be n+1 distinct points, n of which are approximations to the eigenvalues of A. Define

$$g(\lambda) = \prod_{k=0}^{n} (\lambda-\lambda_k),$$

$$g_j(\lambda) = \frac{g(\lambda)}{\lambda-\lambda_j}$$

Then by Lagrange's interpolation formula

$$p(\lambda) = \sum_{j=0}^{n} \frac{p(\lambda_j)\, g_j(\lambda)}{g_j(\lambda_j)} = \sum_{j=0}^{n} \frac{p(\lambda_j)}{g_j(\lambda_j)} \frac{g(\lambda)}{\lambda-\lambda_j} ;$$

where

$$p(\lambda_j) = |\lambda_j I - A|. \quad \text{Setting } c_j = \frac{p(\lambda_j)}{g_j(\lambda_j)}$$

$$p(\lambda) = g(\lambda) \sum_{j=0}^{n} \frac{c_j}{\lambda - \lambda_j}$$

If none of the λ_j's is an eigenvalue, $p(\lambda)$ will be zero if and only if the rational function

$$\sum_{j=0}^{n} \frac{c_j}{\lambda - \lambda_j} = 0.$$

The roots of this function are then taken as better approximations to the eigenvalues and the process is repeated.

The improvement in speed is achieved by the significant reduction in total number of determinant evaluations which are required. However, the difficulty in supplying sufficiently good estimates for the eigenvalues often precludes the usefulness of the procedure.

4. Lanczos' Method:

A fairly rapid method which does not require estimates is that of Lanczos [8]. While the evaluation of a full determinant is time consuming, a tri-diagonal determinant can be evaluated quite rapidly by recursion. This method produces a tridiagonal matrix similar to A.

Starting with arbitrary vectors x_1 and y_1, a biorthogonal set x_1, x_2 ..., x_n; y_1, y_2, ..., y_n is generated by the formulas

$$x_{k+1} = Ax_k - \alpha_k x_k - \beta_{k-1} x_{k-1}$$

$$y_{k+1} = A^* y_k - \bar{\alpha}_k y_k - \bar{\beta}_{k-1} y_{k-1}$$

where $\alpha_k = \frac{(y_k, Ax_k)}{(y_k, x_k)}$ and $\beta_k = \frac{(y_k, Ax_{k-1})}{(y_k, x_k)}$.

The tridiagonal matrix

$$B = \begin{bmatrix} \alpha_1 & \beta_1 & & & & \\ 1 & \alpha_2 & \cdot & & 0 & \\ & \cdot & \cdot & \cdot & & \\ & & \cdot & \cdot & \cdot & \\ & & & \cdot & \cdot & \cdot \\ & 0 & & & \cdot & \alpha_{n-1} \beta_{n-1} \\ & & & & 1 & \alpha_n \end{bmatrix}$$

is similar to A since $B = X^{-1} A X$, where the columns of X are the vectors $x_1, x_2, \ldots, x_n$. The eigenvalues of B are then obtained by the root finding technique.

The method does not yield good accuracy due to difficulties in generating the biorthogonal set. Certain modifications are currently being incorporated in an effort to improve the accuracy.

5. Power Method:

As shown previously, the sequence of vectors y_k becomes parallel to an eigenvector x_1 corresponding to the eigenvalue λ_1 of maximum modulus. The Rayleigh quotient $\frac{(Ax_1, x_1)}{(x_1, x_1)}$ is taken to be the corresponding eigenvalue λ_1. To find the subsequent eigenvalues and eigenvectors the matrix is deflated [10, 13].

Suppose x_1 is normalized so that its last component is 1, $x_1 = \begin{bmatrix} c \\ 1 \end{bmatrix}$ where c is an (n-1)-dimensional vector. Then the matrix

$$S = \begin{array}{c} \left[\begin{array}{c|c} I & c \\ \hline 0 & 1 \end{array}\right] \begin{array}{l} (n-1) \\ (1) \end{array} \\ \begin{array}{cc} (n-1) & (1) \end{array} \end{array} \quad \text{with } S^{-1} = \begin{array}{c} \left[\begin{array}{c|c} I & -c \\ \hline 0 & 1 \end{array}\right] \begin{array}{l} (n-1) \\ (1) \end{array} \\ \begin{array}{cc} (n-1) & (1) \end{array} \end{array}$$

defines a similarity transformation of the matrix

$$A = \begin{array}{cc} \left[\begin{array}{c|c} B & x \\ \hline y & a \end{array}\right] & \begin{array}{c} (n-1) \\ (1) \end{array} \\ \begin{array}{cc} (n-1) & (1) \end{array} & \end{array}$$

which yields

$$A_1 = S^{-1}AS = \begin{array}{cc} \left[\begin{array}{c|c} A' & 0 \\ \hline y & 1 \end{array}\right] & \begin{array}{c} (n-1) \\ (1) \end{array} \\ \begin{array}{cc} (n-1) & (1) \end{array} & \end{array}$$

where $A' = B - cy$ is of order n-1. Since A_1 is similar to A, the eigenvalues of A' must be the same as those of A except for λ_1.

The basic iteration process is then applied to A' producing an eigenvector x_2' corresponding to the dominant eigenvalue λ_2 of A'. The eigenvector x_2 of A corresponding to λ_2 is then recovered using x_2'. This process is continued until all the eigenvalues and eigenvectors of A are obtained. The process of recovery of eigenvectors breaks down, however, for a multiple eigenvalue λ if the number of linearly independent eigenvectors corresponding to λ is less than its multiplicity.

The rate of convergence of the basic iteration process at any stage is a function of the ratio of the magnitudes of the two dominant eigenvalues. In fact, one may define the rate of convergence to be the logarithm of this ratio, $r = \log \left| \frac{\lambda_1}{\lambda_2} \right|$. If the two dominant eigenvalues lie close to the same circle, the basic iteration process converges very slowly. Two techniques are used to improve convergence in such circumstances. One is to iterate with the matrix $(A - \alpha I)$ instead of A for some appropriate value of α. This effects a translation of the origin in the λ-plane but leaves the eigenvectors invariant. The second technique for improving convergence is to use an acceleration procedure. Wilkinson [10] employs the Aitken δ^2 acceleration which in addition to a least squares acceleration procedure, have been programmed and investigated by E. Osborne at The Ramo-Wooldridge Corporation. The details of this work will be presented in a forthcoming paper.

6. Wielandt's Method:

This is a power method for improving the accuracy of an approximate eigenvalue μ and a corresponding eigenvector z. Set $y_o = z$ and perform the iteration

$$c_{i+1}(A - \mu I)\, y_{i+1} = y_i$$

where the c's are normalizing factors. This is essentially the power method with the matrix $(A - \mu I)^{-1}$. If μ is closest to some eigenvalue λ of A, then $\frac{1}{\lambda - \mu}$ will be the dominant eigenvalue of $(A - \mu I)^{-1}$. Hence the sequence of vectors y_i will tend to an eigenvector x of $(A - \mu I)^{-1}$ corresponding to the eigenvalue $(\lambda - \mu)^{-1}$. Thus

$$(A - \mu I)^{-1}x = (\lambda - \mu)^{-1}x$$

or

$$(A - \mu I)x = (\lambda - \mu)x.$$

Hence $Ax = \lambda x$ so that the improved eigenvalue and corresponding eigenvector are obtained.

7. Generalized Eigenvalue Problem:

Let A(x) be a matrix of order n with elements which are polynomials in a variable x. It is required to find the values of x for which the determinant of A(x) vanishes.

Let k be the degree of the polynomial of highest degree in A(x). Then

$$A(x) = A_o x^k + A_1 x^{k-1} + \ldots + A_k$$

where the A_i $(i = 0, \ldots, k)$ are constant matrices and $A_o \neq 0$. This is a generalization of the standard eigenvalue problem for a matrix M in which $k = 1$, $A_o = I$ and $A_1 = -M$.

This problem could be transformed into a standard eigenvalue problem for a matrix of order kn if A_o or A_k is non-singular and then handled by one of the previously mentioned routines. However, in the problems required for solution

A_o was always singular and frequently so was A_k. It was then decided to use determinant evaluation coupled with root finding as in the method first described.

To reduce computation time the root finding technique was modified to incorporate the use of estimates of the eigenvalues if available. This was done in such a way that convergence is obtained even with virtually arbitrary estimates. The advantage of good estimates is a reduction in the required computing time up to a factor of 3. This is to be contrasted with Leppert's method which requires very good estimates for successful operation.

NUMERICAL RESULTS

1. General Remarks:

In order to study the effectiveness of the various numerical methods coded for the UNIVAC Scientific 1103 Computer, a set of test matrices was selected in order to compare the procedures with respect to time, accuracy and universality of application. These matrices varied in order and in the relative proximity of their roots. The eigenvalues were known by virtue of the construction of the matrix or from known analytic expressions. Examples of such test matrices are displayed in Figure I. The results of the comparisons are contained in the accompanying table. and graphs.

In general, all of the methods considered offered no difficulties for most matrices of order less than ten. Also the time needed to carry out the calculation is within reasonable bounds. However, two important problems arise for orders larger than ten:

a. Running time increases due to the number of arithmetic operations which is of order N^2 or N^3 depending on the method. Also matrix storage space is of order N^2 and requires the eventual employment of the slower access auxiliary storages.

b. Round-off errors build up due to the many more arithmetic manipulations and significantly affect the results.

In addition to these statements further difficulties are encountered by all the methods for matrices possessing clustered eigenvalues and/or eigenvalues of equal moduli. In such instances the rate of convergence is reduced considerably and loss in accuracy of the roots occurs.

The subroutines which were prepared employ The Ramo-Wooldridge interpretive complex floating point arithmetic package. In order that the accompanying numerical results be meaningful relative to other machines it is necessary to state some of the characteriszations of this arithmetic system:

a. Floating point number characteristics

1-register precision - 8 bit exponent, 27 bit mantissa for each component

2-register precision - 8 bit exponent, 62 bit mantissa for each component

b. Times for basic operations (in milliseconds)

	1-register precision	2-register precision
addition	3.4	12
multiplication	7.5	35
division	13.0	67

c. The output routines used for both precisions displayed numbers to 8 decimal digits and the corresponding tens exponent.

2. Observations and Recommendations:

a. Slowness and control of round-off are associated with the methods which continually operate on the input matrix. This includes the determinant evaluating procedure, the method of Leppert and the power methods. Of course, it should be recalled that the later method also obtains eigenvectors. Speed and inaccuracy are characteristic for the methods of Lanczos and Danilewski which operate on the condensed data obtained from the original matrix by similarity transformations. The inaccuracy results from the small errors in this data which can lead to large errors in the eigenvalues. (Figures 2 and 3)

b. While Figure 3 displays the accuracy for the least accurate eigenvalue found it is significant that most of the remaining eigenvalues lost only several digits and that the most accurate one was found to 7 or 8 places. It was generally noted that roots which were not clustered were obtained with better accuracy.

c. While all the methods require storage of the input matrix, much of the computation of the procedures of Danilewski and Lanczos is done on a concentrated form of the data. (Table I)

d. The effect of increasing the precision of the arithmetic was investigated for the method of Danilewski. For a given family of matrices, Figures 4 and 5 show the effects of employing more precision in the arithmetic on the round-off errors generated in performing the similarity transformations. It appears from Figure 4 and other similar investigations, that the accuracy curve for two register precision is related to the accuracy curve for one register precision by a fixed translation being approximately equal to the number of decimal digits by which the former mantissa exceeds the latter.

e. Rates of convergence and number of digits of accuracy in results are decidedly affected by relative positions of the eigenvalues in the complex plane. In addition to the troublesome "close" roots which cause difficulties for all the methods considered, the power method also suffers from roots having approximately equal moduli. By suitable shifts in the origin and/or by certain acceleration techniques this difficulty can be overcome in many instances. In optimal cases convergence is fast with excellent accuracy in the results. The time requirements are reasonable, especially since eigenvectors are obtained along with the eigenvalues. It can be stated that on the average one to two hours is required for matrices of order 20. Further investigation into the possibility of automatizing the determination of optimal origins and into the acceleration techniques might make this method a practical one for matrices of order greater than 20. These matters are currently being investigated.

f. Not all the methods can operate successfully without some knowledge of the eigenvalues sought. In fact, some of the procedures require very good estimates of the eigenvalues. (Table II)

g. Difficulties due to the limitations of an interpretive arithmetic are not to be discounted. Even with floating point, problems arise in keeping the complete calculation for large order matrices within the range of the number representation of the arithmetic. Rescaling of the input data can overcome some of these difficulties. Other problems concern themselves with loss of accuracy due to subtractions of approximately equal numbers and to decide upon convergence criteria which are consistent with the floating point operation.

h. While some methods combine speed and inaccuracy, others are slow and accurate. It seems natural to attempt to combine the desirable features of both by first obtaining rough estimates of the eigenvalues by use of the methods of Lanczos or Danilewski and then to refine them by entry to a refining routine. Indeed such a procedure was carried out and results obtained for matrices of order 20. Another technique might find an almost triangular matrix B similar to the input matrix A. By an almost triangular matrix is meant one whose elements below (or above) the main diagonal are all zero, except for the diagonal just adjacent to the main diagonal. Performing now the determinant evaluation procedure with $|B - \lambda I|$ we obtain eigenvalues which can then be refined by one or more iterations with $|A - \lambda I|$. Preliminary investigations indicate a possible saving in time over the current procedure by a factor of $2N/3$. Further investigations to cut this time are in progress since the accuracy accruing in the determinant evaluation procedure makes it desirable to apply the method to matrices of order higher than 20.

An even more elaborate procedure might employ the technique of successively reducing the order of the matrix after finding each root. In order to do this the eigenvector associated with each root must also be found, say by the method of Wielandt, and a matrix reduction routine entered.

i. Considerable saving in computing time can be realized by a judicious choice of the type of arithmetic employed. For real matrices it is possible, in some cases where knowledge of the location of the eigenvalues is known, to operate wholly in real arithmetic. Certainly for all real matrices the similarity transformations used in the schemes of Lanczos and Danilewski can be performed in real arithmetic. While double precision may be required for part of a problem it may not be essential for the entire calculation. For example, one may wish to evaluate the determinant of $|A - \lambda I|$ in multi-precision and carry out the root finding in single precision. Again the similarity transformation in the methods of Lanczos and Danilewski are instances of where multi-precision could be used for the first part of the problem and single-precision employed for the final part. In any case, savings in time by factors of from 2 to 5 can be obtained going from multi-precision to single-precision or from complex to real arithmetic.

The authors wish to express their gratitude to Dr. G. E. Forsythe whose informal notes on the various methods and guidance in the development of the routines proved invaluable. Acknowledgement is made to the contributions of C. Farrington, G. Golub, E. Osborne, and R. Gregory who programmed some of the methods. Our thanks are also due to R. Anderson and J. Ortlip who aided in testing the routines. The entire study was under the supervision of Dr. D. M. Young, Jr.

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Total Storage Requirements (independent of interpretive routines)

Method	Number of Words in Code	Data and Temporary Storage where N is the Order of the Matrix
Danilewski	385	Part I $2N^2 + 6N$ Part II $6N + 41$
Determinant Evaluation	273	$3N^2 + 5N$
Leppert (2 register precision)	322	$6N^2 + 22N + 32$
Lanczos	430	Part I $2N^2 + 16N + 8$ Part II $6N + 28$
Wilkinson	541	$2N^2 + 13N + 10$
Wielandt	392	$3N^2 + 9N + 4$
Generalized Eigen-value Problem	288	$2(k+2)\ N^2 + 5N + 2R + 18$ k = degree of the poly-nomial of highest degree in A(x) R = number of roots desired

Table I

	Method	Time	Accuracy	Starting Procedure	Multiple Roots (Accuracy and Convergence Deteriorates)
Eigenvalues Only	Danilewski	Very fast	Poor	None	Yes
	Determinant Evaluation	Extremely Slow	Good	None	Yes
	Leppert	Slow	Good	Very good estimates of eigenvalues	No
	Lanczos	Fast	Fair	Two arbitrary vectors in most cases	Provision for multiple roots not included
Eigenvalues and Eigenvectors	Wilkinson	——	Good	Arbitrary, but knowledge of location of eigenvalues speeds convergence	Yes, if the number of eigenvectors is equal to the multiplicity of the eigenvalue
	Wielandt	——	Good	Estimates of Eigenvalues and Eigenvectors	Provision for multiple roots not included

Evaluation of various methods for obtaining eigenvalues and/or eigenvectors based on results obtained for $N \geq 10$.

Table II

$$A = \begin{pmatrix} 1 & -1 & 0 & 0 & 0 & . & . & 0 \\ -1 & 2 & -1 & 0 & 0 & . & . & 0 \\ 0 & -1 & 2 & -1 & 0 & . & . & 0 \\ . & . & . & . & . & . & . & . \\ 0 & 0 & . & . & . & -1 & 2 & -1 \\ 0 & 0 & . & . & . & 0 & -1 & 2 \end{pmatrix} \qquad A^{-1} = \begin{pmatrix} N & N-1 & N-2 & . & . & . & 1 \\ N-1 & N-1 & N-2 & . & . & . & 1 \\ N-2 & N-2 & N-2 & . & . & . & 1 \\ . & . & . & . & . & . & . \\ 2 & 2 & 2 & . & . & . & 1 \\ 1 & 1 & 1 & . & . & . & 1 \end{pmatrix}$$

The eigenvalues of A and A^{-1} are given by λ_j and λ_j^{-1} respectively where:

$$\lambda_j = \left(2 \sin \frac{\alpha_j}{2}\right)^2 \quad , \quad \alpha_j = \frac{2j-1}{2N+1} \pi$$

and the eigenvectors of A and A^{-1} by:

$$\mu_j^{(i)} = \cos \alpha_j \left(i + \frac{1}{2}\right) \qquad i,j = 1,2,\ldots,N$$

1. Test matrix A of order N

$$U = \omega \begin{pmatrix} 0 & 1/2 & 0 & . & . & . & 0 \\ 0 & 0 & 1/2 & . & . & . & 0 \\ 0 & 0 & 0 & 1/2 & . & . & 0 \\ . & . & . & . & . & . & . \\ 0 & 0 & 0 & . & . & . & 1/2 \\ 0 & 0 & 0 & . & . & . & 0 \end{pmatrix} \qquad L = \omega \begin{pmatrix} 0 & 0 & 0 & . & . & . & 0 \\ 1/2 & 0 & 0 & . & . & . & 0 \\ 0 & 1/2 & 0 & . & . & . & 0 \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ 0 & 0 & 0 & . & . & 1/2 & 0 \end{pmatrix}$$

$$B = (I - L)^{-1} \left[U - (\omega - 1) I\right]$$

The eigenvalues of B are the roots λ_j of

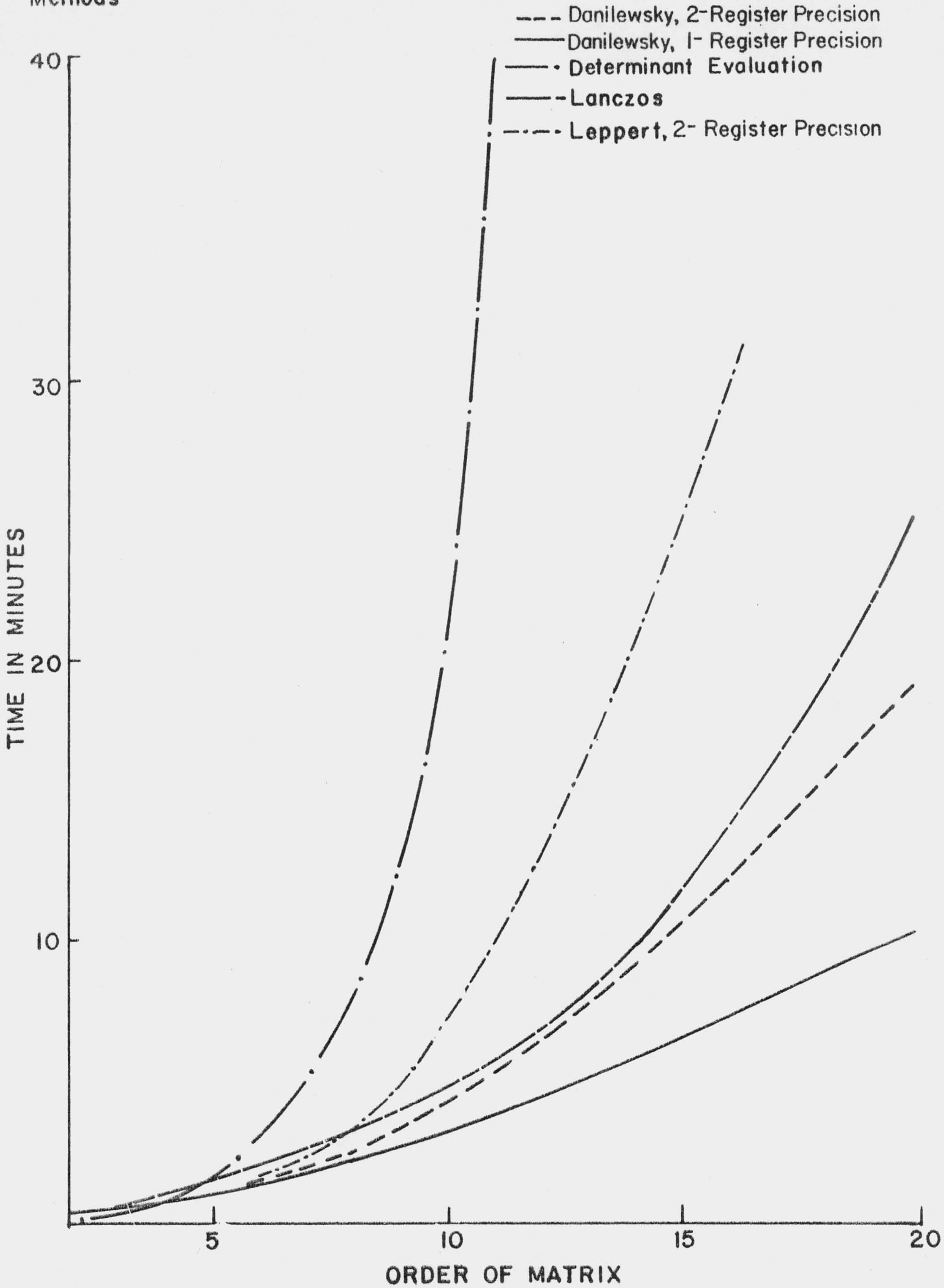
$$\lambda_j + (\omega - 1) = \omega \mu_j \lambda_j^{\frac{1}{2}} \qquad j = 1,2,\ldots,N$$

where $\mu_j = \cos \frac{j\pi}{N+1}$

2. Test matrix B of order N, ω arbitrary

Figure 1

Computing Time for Eigenvalues as a Function of N for the Following Methods



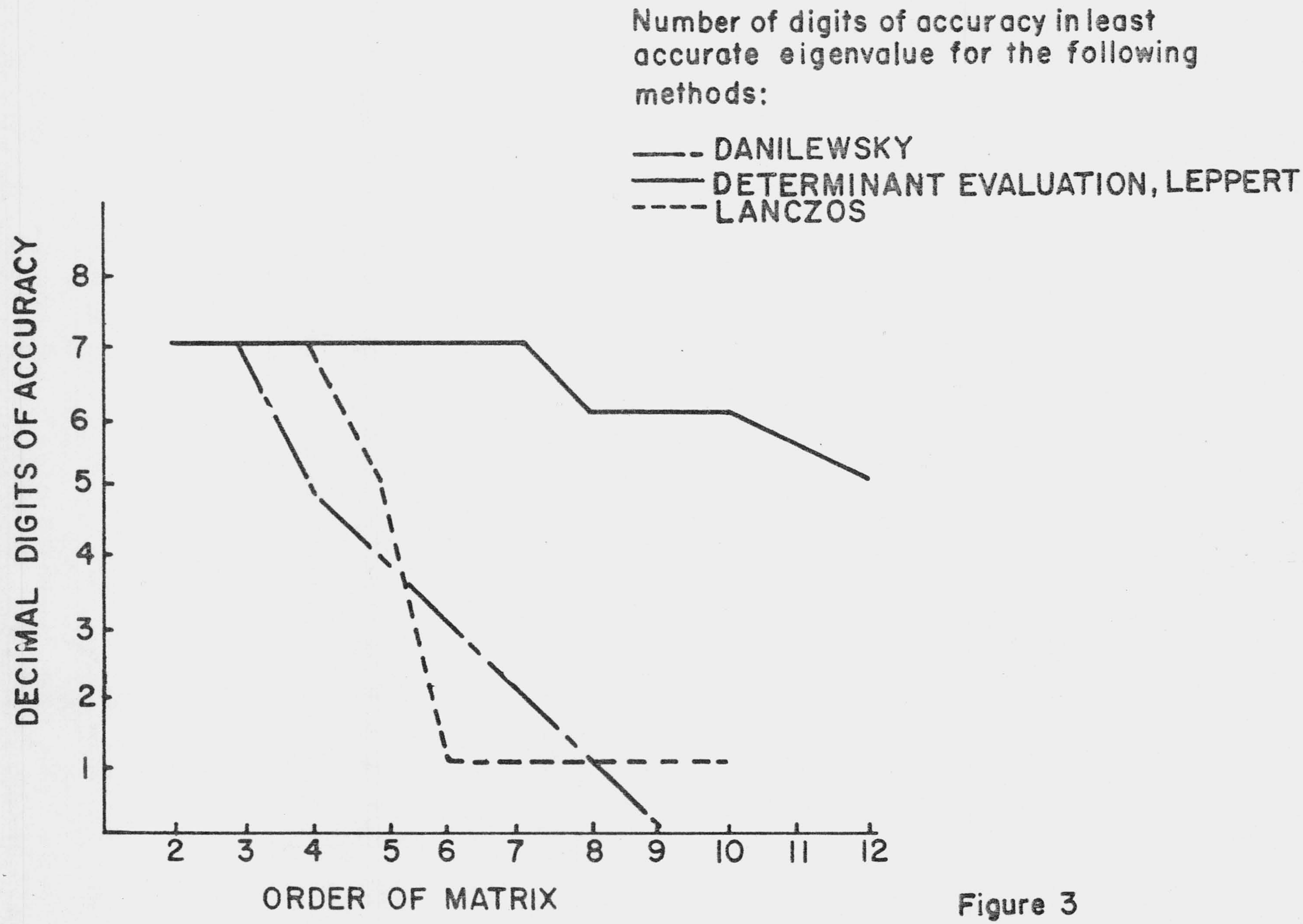
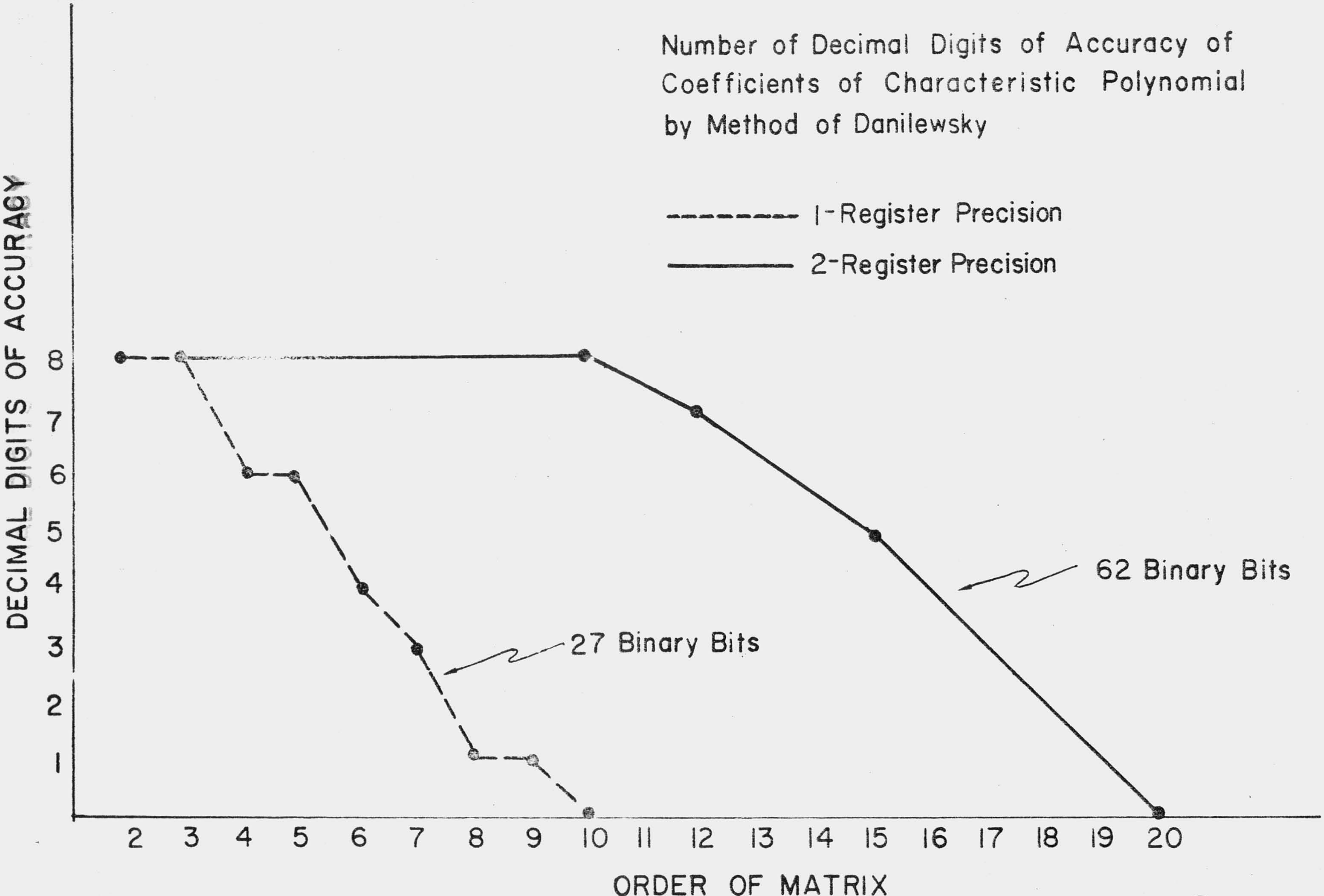

Number of digits of accuracy in least accurate eigenvalue for the following methods:
DANILEWSKY
DETERMINANT EVALUATION, LEPPERT
LANCZOS
DECIMAL DIGITS OF ACCURACY
1
2
3
4
5
6
7
8
2
3
4
5
6
7
8
9
10
11
12
ORDER OF MATRIX

Figure 3



Number of Decimal Digits of Accuracy of Coefficients of Characteristic Polynomial by Method of Danilewsky
1-Register Precision
2-Register Precision
62 Binary Bits
27 Binary Bits
DECIMAL DIGITS OF ACCURACY
1 2 3 4 5 6 7 8
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
ORDER OF MATRIX

Figure 4

Range of accuracy of eigenvalues obtained by method of Danilewsky, where coefficients of characteristic polynomial are obtained by

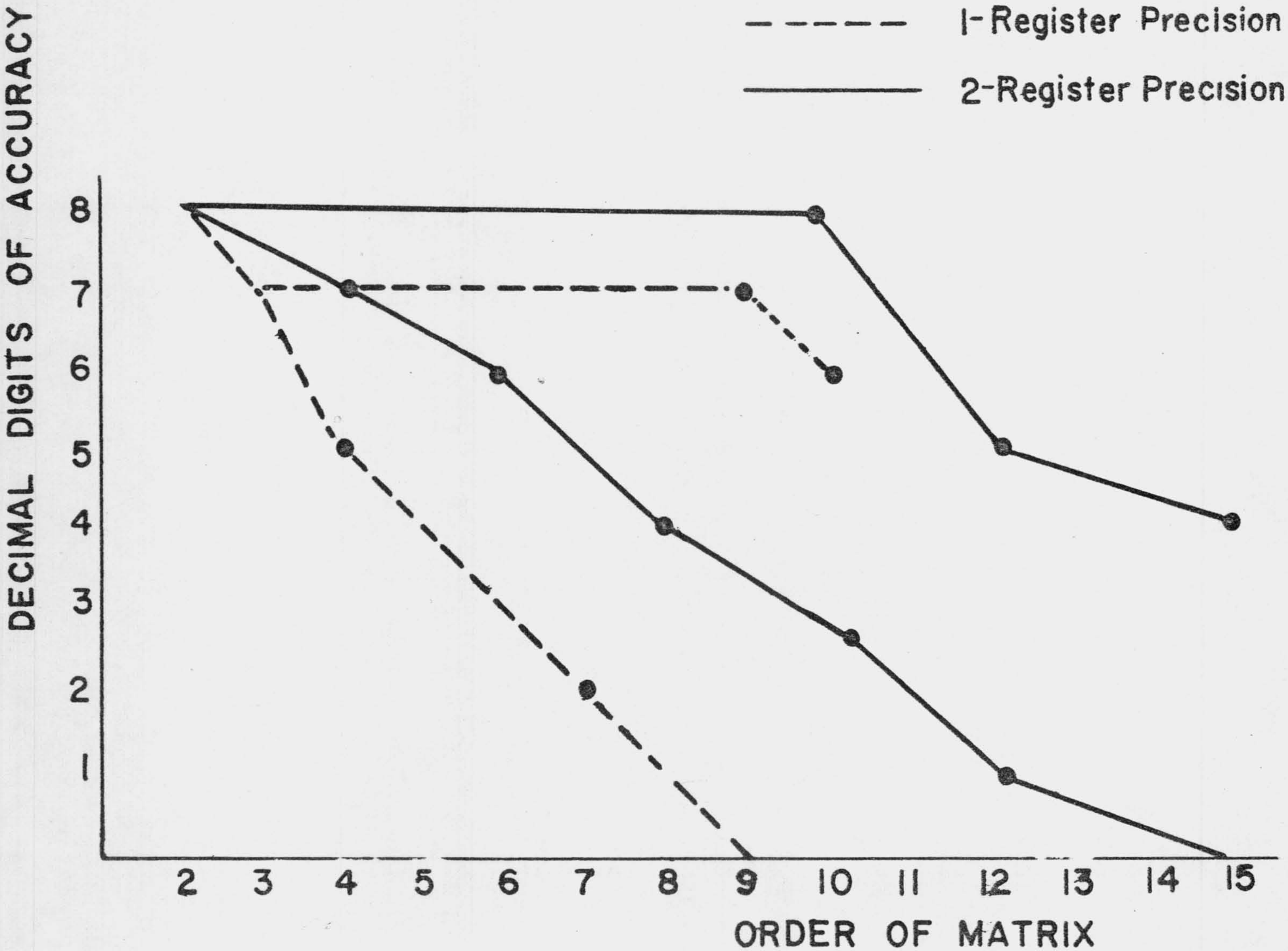


Figure 5

Appendix D

Notes of P. T. Mielke

USE Mathematics Subcommittee Meeting

July 25, 1957

Mr. Chairman, it is a privilege to be able to discuss with this group a subject which has been of great interest to dynamicists at Boeing for a long time, particularly since the advent of large scale, high speed digital computers. I refer to the problem of determining the eigenvalues of complex matrices of large order.

Although this is a meeting of mathematicians for whom it would suffice to treat exclusively of the mathematical aspects of this subject, I know that as mathematicians you will also appreciate that it often helps to motivate abstract definition by referring to the physical world. In fact, for applied mathematicians this is a necessity. Therefore, I make no apology for beginning with a brief discussion of one of the physical bases of the complex eigenvalue problem.

This immediately presents a problem to an employee of a company such as Boeing. Our proprietary and military interests dictate care in detail while discussing our problems. Therefore, when I mention large, elastic airplanes characterized by large external stores attached by elastic supports I could be speaking of a Convair 880 or a Douglas DC8 as well as of several familiar Boeing products. Furthermore, I will forebear to discuss the details of such airplanes except to point out that their great flexibility is the reason why we are interested in the eigenvalue problem for large matrices.

What, then, is within the purview of the dynamics engineer? Briefly, we are interested in two problem areas. Control dynamics includes within its realm of interest all those items of equipment or "structure" in an airplane which serve to maintain its stability in flight and which control its normal motions. Such items would include, for example, all control surfaces and their driving mechanisms. Structural dynamics includes the motions of the primary structure of the airplane and its equipment, generally in response to external environment or to the excitations produced by engines. It is of these problems that I shall speak.

The problems of structural dynamics may be further categorized as follows:

1. Dynamic loads
2. Environmental vibrations
3. Flutter

Problems of the first category are characterized by systems of differential equations of the following type:

$$A\ddot{q} + B\dot{q} + Cq = \alpha(t)$$

where A, B and C are usually real matrices of constants and q, $\dot{q}$, $\ddot{q}$ and $\alpha(t)$ are column vectors. The forcing function $\alpha(t)$ is usually of a transient or random nature such as the forces caused by a gust of air or the bumps in a runway. Primary interest here is in the transient response of the system, so we have an initial value problem in differential equations. Problems of the second category are largely empirical, although computers are being used increasingly, along with analog-digital conversion equipment, to analyze (for example) the power spectra of random signals impinging upon equipment.

The third category of problem leads directly to the point of today's meeting. Flutter may be described briefly (1, page 2*) as a dynamic instability of the airplane in which its elasticity plays an essential role. It will occur if the airplane absorbs energy from the airstream. The velocity at which the structure neither contributes nor absorbs energy is called the critical or flutter velocity.

Flutter may be characterized analytically by systems of differential equations of the form

$$M\ddot{q} + C(1+ig)q + \frac{1}{\Gamma} A(k)\omega^2 q = 0 \qquad (1)$$

*Numbers in parenthesis refer to the bibliography.

M is a real, symmetric positive-definite matrix expressing the inertia properties of the system. It arises simply from the kinetic energy term in the Lagrange equations of the system. C is the so-called stiffness term arising from the potential energy term in Lagrange's equations. Physical assumptions often dictate that C be a diagonal matrix. This simplifies the mathematics a bit. The term $1 + ig$ includes the structural damping g. Γ is a scalar function of atmospheric density and A, the source of all our trouble, is a complex matrix whose elements are rather complicated functions of the so-called reduced frequency parameter k ($k = \frac{b\omega}{v}$ where b is some reference length, ω is frequency and v is velocity.) A arises from the oscillatory aerodynamic forces on the structure. These are the incremental forces due to the vibration of the structure.

A moments reflection suffices to infer that flutter is a phenomenon in which a vibratory motion set up in the structure at critical speed will continue at constant amplitude in all the modes of the structure. This fact may be used in the differential equations by assuming that $q = q_0 e^{i\omega t}$ in which case $\ddot{q} = -\omega^2 q$ and our differential system now becomes a homogeneous linear algebraic system in the unknown vector q. Thus

$$\left[M - C\frac{1}{\omega^2}(1 + ig) - \frac{1}{\Gamma}A(k)\right]q = 0 \tag{2}$$

A usual assumption is that g is the same in every mode of the system. Letting $\Omega = \frac{1}{\omega^2}(1 + ig)$ and recalling from elementary algebra the n.a.s.c. that the above system have a non-trivial solution we arrive at the fact that, for flutter,

$$\left|\left[M - \frac{1}{\Gamma}A(k)\right] - C\Omega\right| = 0 \tag{3}$$

where $|\ |$ denotes determinant. At long last we have the eigenvalue problem.

At Boeing we consider the complex eigenvalue problem large if it contains more than a dozen degrees of freedom. We are currently working with as many as 24 modes in an antisymmetric flutter analysis. As mentioned before, great elasticity and the presence of external stores dictate this size.

It must be noted in the above problem that k is also unknown. However, because of the complexity of its involvement, there is virtually no hope of dealing with it in any way but the usual one of assigning it assumed values and solving for Ω. The choice of values for k is one based on engineering experience. It must be a careful choice, for it bears directly on the amounts of machine time used in arriving at desired solutions to problems. In the case of flutter the end result is a plot of velocity against damping. From the definition of k and Ω it may be seen that if k_o be the assigned value of k, then

$$g = \frac{I_m \Omega}{R_e \Omega}$$

and (4)

$$v = \frac{b}{k_o\sqrt{R_e \Omega}} .$$

For an assigned value of k there will, of course, be n pairs (v,g), and for successive values of k there is the sometimes aggravating problem of associating the pairs, one with another. We have not succeeded in automatizing this problem at Boeing, although a common practice is to draw a durve through points for which the associated frequency is the same or nearly so. Thus in an n degree-of-freedom system there will be n curves which may resemble one of the curves on the following plot:

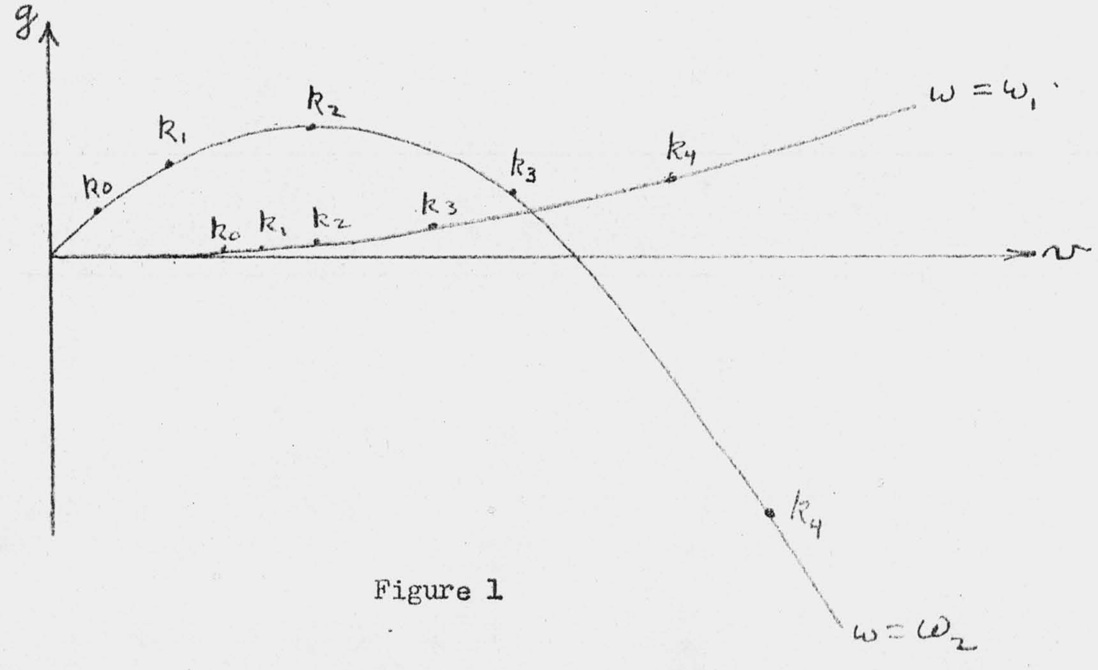


Figure 1

The curves of interest are those which cross the v-axis. I will have occasion to refer to this figure later.

The question then is how to solve the eigenvalue problem just stated. Special properties of the matrices have a direct bearing on the methods used. Tuning of the vibration of external stores with other modes of the system leads to matrices having eigenvalues in close proximity to one another. It is not uncommon to encounter systems having five or more modes whose associated frequencies lie in a range covered by one order of magnitude. Iterative techniques on such matrices consume large amounts of machine time, though less time is consumed in solving for the roots of their characteristic polynomials if these can be obtained.

A further property of flutter stability determinants having direct bearing on programming is that the minimum and maximum moduli of the elements of a matrix may differ by 10^6. Since Boeing has always operated its computer facility on the "open shop" principle and since members of the Dynamics Staff are not so much interested in computer programming as in the results which can be obtained, an early decision was made to use floating arithmetic in all matrix operations. This simplifies programming but consumes time in machines lacking floating arithmetic hardware. We paid the price willingly.

The techniques which we have used to solve the eigenvalue problem fall into all of the three categories:

1. Iteration on the matrices themselves.
2. Development and iteration of the characteristic polynomial.
3. The fraction-series method of Lockheed.

As pointed out previously, the straight power method is slow. It has the excellent advantage, however, that no previous knowledge of the roots of the matrix is needed. We use this method currently in connection with the so-called fraction-series method originated by E. L. Leppert, Jr., and his associates at Lockheed[2]. In the latter method a rational function is developed which has the same roots as the matrix and n+1 poles in the complex plane. That is:

$$f(\Omega) = \sum_{j=1}^{n+1} \frac{C_j}{\Omega - \Omega_j} = 0 \qquad (5)$$

where

$$C_j = \frac{D(\Omega_j)}{\prod_{i \neq j} (\Omega_i - \Omega_j)} \qquad (6)$$

In equations (5) and (6) the quantities Ω_j are guesses for the roots and $D(\Omega_j)$ denotes the determinant of the system evaluated for the guess Ω_j. The accuracy of this method depends upon the accuracy with which the determinants can be evaluated. The method is extremely fast and the iterative method of solving (5) simple. The only shortcoming of the method is that good guesses for the roots of the matrix are needed.

We combine the power and fraction-series methods in the following way for automatic operation. An initial value k_o for k in equation (2) is assumed and the equation put in the proper form for application of the power method which is then used to find the roots. For matrices of 19^{th} order this requires from 20 to 35 minutes of 704 time depending upon the proximity of roots. Note that k is inversely proportional to v. Usually for large values of k iteration is not troublesome, so that experience dictates beginning with large k. Having obtained the roots for the initial k value, this value is then decremented by some preassigned amount. Henceforth the fraction series method is used. Roots from the matrix associated with the previous k value are used as guesses along with zero (n+1 guesses are needed). This procedure may break down for the following reason. As k decreases in value by a constant decrement the points on the curves of Figure 1 space out rapidly, indicating that guesses for roots from the previous k value become less good. Ultimately a point may be reached where the fraction series method fails. If this happens we are currently resorting to iteration which is costly in time. Consequently we are seeking methods of interpolating the coefficients of the fraction series. Generally, however, the method is quite satisfactory, yielding roots for 19^{th} order matrices in about 2-1/2 minutes on the 704 using the SHARE program CL FSC1. It might be argued that a small enough decrement on the k value would quarantee success of the procedure in any case. In practice the values of k_0 and Δ k are preassigned and all the airforce matrices calculated at once. Having to change Δ k in the midst of solving the flutter stability determinants would necessitate either returning to the airforce calculations or developing a method for interpolating on the fraction-series coefficients.

Methods of developing the characteristic polynomial of a matrix are always appealing because of their speed, but I fear that they will always suffer to some degree from a fault which may be exemplified by Krylov's method[3]. If $f(x)=x^n + a_1 x^{n-1} + \dots + a_n$ be the characteristic polynomial of A, then

$$A^n + a_1 A^{n-1} + \dots + a_n = 0$$

and if $\{q_0\}$ be an arbitrary column, then

$$\{A^n q_0\} + a_1 \{A^{n-1} q_0\} + \dots + a_n \{q_0\} = 0 \qquad (7)$$

and we have a linear system for the coefficients a_i. However, for large n and fairly well spaced roots the determinant of the system (7) is nearly singular, hence presents computing problems. We have used the method of Danielewski[3] with only mixed success on one of our computers. It's a very fast method as might be guessed from Wayland's excellent article[3]. We are now programming it for the 704 but suspect it may require double precision arithmetic for matrices of the size in which we are interested.

Once the polynomial is obtained we use a very satisfactory iterative procedure for its roots[4]. The iteration is defined by

$$\Omega_{n+1} = \Omega_n - \frac{2\, f'(\Omega_n)\, f(\Omega_n)}{2\left[f'(\Omega_n)\right]^2 - f(\Omega_n)\, f''(\Omega_n)}$$

Polynomials up to 25th order have been handled easily by this method.

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2. SHARE Program CL FSC1 for the 704.

3. Wayland, H., "Expansion of Determinantal Equations into Polynomial Form"; Quarterly of Applied Mathematics, Vol. II, No. 4, p. 277.

4. Mathematical Tables and Aids to Computation; Vol. 5, No. 35, July 1951, p. 183.

Appendix E

Distributions at Mathematics Committee

1. "Lewis Flight Propulsion Laboratory Experience with Large Systems of Equations", L. R. Turner, National Advisory Committee for Aeronautics, Cleveland, Ohio

2. "A Direct Matrix Method Applied to a Two-Group-Multiregion Nuclear Reactor", G. J. Moshos, National Advisory Committee for Aeronautics, Cleveland, Ohio

3. "Status of USE Spectral Analysis Program", H. Shaw, Applied Physics Laboratory, Johns Hopkins University

4. Notes of P. T. Mielke, Boeing Airplane Co., Seattle, Washington (Appendix D).

A DESCRIPTION OF BRYAN'S METHOD

B. D. Rudin

Reference: Romberg and Keenan, Characteristic Equation of a Matrix, University of Rochester Computing Center Mimeographed Notes.

Let A_k denote the $k \leq n$ order square submatrix of the n-th order square matrix A defined as follows:

$$A_k = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1k} \\ a_{21} & a_{22} & & \\ \vdots & & \ddots & \\ a_{k1} & \cdots & \cdots & a_{kk} \end{bmatrix}.$$

Let a_k denote the k-th row of A_k and partition A_k as follows:

$$A_k = \begin{bmatrix} \alpha_k \\ \cdots\cdots \\ a_k \end{bmatrix}.$$

In a similar manner, let the k-th order square matrix ${}^kB$ be partitioned as follows:

$${}^kB = \begin{bmatrix} {}^k\beta \\ \cdots\cdots \\ b_k \end{bmatrix},$$

where b_k is the k-th row of ${}^kB$. Let ${}^k\beta_j$ and ${}^kB_j$ denote the j-th columns of ${}^k\beta$ and ${}^kB$ respectively.

We start with the row vector

$$b_2 = (a_{11} \ \ -1),$$

and the column vector

$${}^2B_2 = (0 \ -1).$$

Then

$${}^2\beta_1 = \alpha_1 {}^2B_2 \equiv (a_{11} \ \ a_{12}) \begin{pmatrix} 0 \\ -1 \end{pmatrix}.$$

Also, the (j+1) -st element of b_3 is given by

$$b_{3,j+1} = a_2 {}^2B_{j+1} - b_{2j} \ ; \ j = 0, 1, 2,$$

where it is understood that if a subscript on the right hand side contains a zero or a number greater than 2, then the corresponding vector or scalar is zero. In this case,

$$b_{20} = 0 \ , \ {}^2B_3 = 0.$$

The general step is then as follows:

$${}^kB_k = (\ 0 \ 0 \ \ldots \ 0 \ (-1)^{k-1}),$$

$${}^k\beta_{j-1} = \alpha_k {}^kB_j \ ; \ j=k, \ k-1, \ \ldots, \ 2, \ 1.$$

$$b_{k+1, \ j+1} = a_k {}^kB_{j+1} - b_{kj} \ ; \ j=0, \ 1, \ \ldots, \ k.$$

where $b_{kj} = 0$ if $j = 0$ and ${}^{k}B_{j+1} = 0$ if $j = k$. Then

$$b_{m+1} \begin{pmatrix} 1 \\ \lambda \\ \lambda^{2} \\ \cdot \\ \cdot \\ \cdot \\ \lambda^{n} \end{pmatrix} = f(\lambda),$$

the characteristic polynomial. Furthermore,

$$C = {}^{n}B \begin{pmatrix} 1 \\ \lambda \\ \cdot \\ \cdot \\ \cdot \\ \lambda^{n-1} \end{pmatrix}$$

is a characteristic vector if λ is a root of the characteristic polynomial.

Appendix G

REPORT OF MATHEMATICS COMMITTEE TO POLICY COMMITTEE

1. In view of the efforts in finding eigenvalues and eigenvectors of arbitrary matrices at The Ramo-Wooldridge Corporation, the general needs of USE members will be satisfied by the routines prepared there for medium size matrices.
2. Lockheed will prepare a routine employing a new method for the finding of the characteristic equation of a matrix and compare this with existing methods.
3. The committee recognizes the importance of the forthcoming Wayne Conference on matrix computation to the computing field and especially to the topic for this meeting. It is hoped that a report of this meeting can be made to the Mathematics Committee at the next session by members who will attend.
4. Members of the Mathematics Committee are requested to bring to the next meeting a set of test matrices for the purpose of measuring the adequacy of existing routines for finding eigenvalues and eigenvectors and also for solving linear systems.
5. The topic of Ordinary Differential Equations is the theme of the next meeting as decided by the Policy Committee at the Dayton meeting.
6. The Mathematics Committee would prefer more than two half-day sessions prior to turning in its report to the Policy Committee.

James A. Ward
Chairman

July 26, 1957

Talmadge

20 August 1957

To All USE Members:

Attached is the list of the mnemonic codes of the IP instructions adopted as standard at the last USE Meeting.

Very truly yours,

W E McVicar

W. E. McVicar
Executive Secretary, USE
Remington Rand Univac
Division of Sperry Rand Corp.
Univac Park
St. Paul 16, Minnesota

WEM/lmj

BASIC OPERATIONS

OCTAL	NMEMONICS	FUNCTION
00	LDR	Load Result Storage
01	LFR	Load F and R
02	ADD	Add
03	SBT	Subtract
04	MPY	Multiply
05	MPA	Multiply Add
06	PMP	Polynomial Multiply
07	DIV	Divide
10	SQR	Square Root
11	SIN	Sine
12	COS	Cosine
13	EXP	Exponential
14	LOG	Logarithm
15	ATN	Arctangent
20	STU	Store Unrounded
21	BTU	Block Transfer Unrounded
22	FIX	Floating to Fixed
23	FLT	Fixed to Floating
24	STR	Store Rounded
25	BTR	Block Transfer Rounded
77	NOP	No Operation
76	LBB	Locate B-Boxes
16	CIP	Conjugate Inner Product
17	NIP	Non-conjugate Inner Product
26	LDP	Load Positive
27	LDN	Load Negative
66	LDM	Load Magnitude
67	ADM	Add Magnitude

MATRIX OPERATIONS

OCTAL	MNEMONICS	FUNCTION
30	MADD	Add
31	MSBT	Subtract
32	MMPY	Multiply
33	MTRM	Transmit
34	MTRP	Transpose
35	MINV	Inverse
36	MSMP	Scalar Multiply
37	MDAD	Diagonal ADD
40	MSPR	Spur
41	MDET	Determinant
42	MROW	Row Select
43	MCOL	Column Select
44	MPAR	Partition
45	MRPL	Replace
47	MSET	Bank Set

DOUBLE PRECISION OPERATIONS

OCTAL	MNEMONICS	FUNCTION
50	DLDR	Load Result Storage
51	DLFR	Load F and R
52	DADD	Add
53	DSBT	Subtract
54	DMPY	Multiply
55	DMPA	Multiply Add
56	DPMP	Polynomial Multiply
57	DDIV	Divide
60	DSQR	Square Root
61	DSIN	Sine
62	DCOS	Cosine
63	DEXP	Exponential
64	DLOG	Logarithm
65	DATN	Arctangent
70	DSTU	Store Result Unrounded
71	DBTU	Block Transfer Unrounded
72	DFIX	Floating to Fixed
73	DFLT	Fixed to Floating
74	DSTR	Store Result Rounded
75	DBTR	Block Transfer Rounded

Talmadge

. USE ORGANIZATION MEETING

July 25 and 26, 1957

Seattle, Washington

Report of the Program Development Committee

The Program Development Committee met Thursday afternoon, July 24 and Friday morning, July 25. Appendix A contains a list of the persons attending one or more of the meetings.

Agenda

The Policy Committee recommended the following items for the agenda of the Program Development Committee:

1. Status of print edit routine
2. Status of USE Compiler
3. Other coding assignments
4. Cataloging system for USE programs
5. Report of the sub-committee on mnemonic interpretive codes and their octal equivalents
6. Report on status of Unicode
7. Recommendations on the contents of subroutine writeups
8. Report on other coding assignments
9. Discussion of tape anomalies by Holloman and others
10. Discussion of tape bad spot program
11. Further discussion of the result of the Los Angeles meeting on information exchange

The following items were added to the agenda in the committee meeting:

1. Specifications for a common alarm exit program (WF)
2. Headings in USE Compiler (WF)

Status of USE Compiler

Robert Perkins (RW) reported on the progress on the USE Compiler. The modified version of the USE Compiler has been completed and Perkins brought with him three sets of binary decks for each of the following programs: 1) The USE Compiler itself, 2) a program for making a tape subroutine library, 3) a binary load program. He also distributed some written explanatory material. The first was a writeup of approximately 16 pages on how to use the USE Compiler from the operational standpoint. This writeup also contained instructions on how to use the tape library program and the binary loader. Also submitted was a writeup describing the various warning codes which are issued by the USE Compiler. In addition, a sample program, or rather a sheet containing several lines of coding, along with the resulting output side-by-side listing produced by the USE Compiler of these lines of coding was presented. The Corps of Engineers and the Bureau of Census each obtained a set of the binary decks. The complete package will be mailed to each of the other installations within one week of this meeting. The package will include the decks and all the writeups here described.

The version of the Compiler distributed at this meeting has been changed in several respects from the original version which has been in use at both the Corps of Engineers and at Ramo-Wooldridge since approximately January, 1957. The major changes are a modification in the format of the output listing, a new and improved form of the binary magnetic tape produced by the Compiler, and a modification in the re-compiling process to take advantage of the semi-columnar format of the output listing. This latter change has increased the speed of the Compiler so that it compiles more than $3\frac{1}{2}$ instructions per second during re-compiling from magnetic tape. This figure is based on only a small sample--however, it is believed the sample is representative.

Perkins said this version of the USE Compiler represents a plateau and that further improvements are to be made in the next version. In particular, this next version will include the ability to translate mnemonic operation codes which are to be treated as instructions to be interpreted. Some further changes are expected in the handling of subroutines and efforts will be continued to make the compiler faster.

There followed a discussion of certain details of the Compiler both from the standpoint of the operation of the Compiler and from the standpoint of the programmer writing codes in USE Compiler language. Certain members again stressed a need for a modified compiler manual, particularly one with a better writeup of how subroutines are used. The writeup should include examples of various lines of coding whever appropriate. It was felt that the sample code and the resulting side-by-side listing distributed at this meeting would be of considerable help when used in conjunction with the USE Compiler Programming Manual issued in October of 1956. A writeup on the form of standard USE subroutines and the format of the contents of the writeup will be distributed, but not as part of the USE Compiler Programming Manual.

Report on Print Edit Routine

F. W. Bauer (WF) reported that the Wright Field Generalized Output Editing Routine has been completed. He passed out a sample of some output produced by the Edit Routine along with certain number conversion programs which Wright Field has completed. The program was checked out using the APL 1103A on time donated to the USE Organization by Remington-Rand. Bauer submitted, for transmission to the Executive Secretary, Ozalid masters of five standard USE Subroutines as follows:

WF0001 - The Print Edit Subroutine
WF0002 - Octal Number Conversion
WF0003 - Stated Point Binary to Decimal Conversion
WF0004 - Floating Point Binary to Decimal Conversion
WF0005 - Alphanumeric Subroutine

The last mentioned subroutine does nothing more than copy words unchanged onto magnetic tape--it is used for column headings and tape titles, etc.

Some interest was expressed in making available at least three more number conversion routines to work in conjunction with the Wright Field Edit Routine, namely Stated Point Numbers Output in Floating Point Form, Floating Point Numbers Output in Stated Point Form, and Double Precision Floating Point Output. After an informal survey of available manpower at each of the represented installations, it was determined that the demand for, and the interest in, these additional routines was not sufficient to warrant the expenditure of any manpower at this time. Some installations indicated that they might have programmers available within a few months to take on additional coding assignments of this type.

Tantzen (HO) briefly described a card output routine which has been developed at Holloman for their use in the absence of a High Speed Printer. From the specifications it appeared that such a routine might indeed be of interest to other organizations and Holloman will submit their writeup of this program as a USEful Note.

Tape Anomalies

Tantzen (HO) described the following anomalous behavior which had been discovered on the Holloman 1103A. An EF instruction to move n blocks forward is executed, then an EF to read 1 block backwards is executed, then the computer hangs up on the first external read instruction. The Holloman engineers have been unable to discover the reason for this improper behavior on the part of the tape units. Tantzen said that the converse of this sequence, namely moving backwards first and then reading one block forward has worked correctly. No one was able to offer an explanation.

Laure (CE) described a difficulty in the Corps of Engineers machine when using the variable block reading and recording. The difficulty arises in trying to find the end of record signal when reading backwards into the leader section of the magnetic tape. In all cases the end of record signal did not appear in IOA. However, when the tape was read backwards the proper number of blocks into the leader position, there was no sprocket error or other incorrect behavior.

Combelic (RW) described a difficulty experienced with the Lockheed and the Ramo-Wooldridge tape units. This behavior arose because extraneous bits were put into IOA upon turning off the Ferranti light. The symptoms were that a free running read was executed and after reading the first block, IOA was examined, found to be non-zero which indicated a parity error. Consequently, the tape was reversed and the EF code to back one block was executed. However, because there had not been an actual parity error which would have cleared the tape control register, a logical sum of the two EF codes went into the tape control register and this EF code was equivalent to writing forward in the free run mode. The result of this behavior was to write zeros on the magnetic tape until it was manually stopped.

Program for Detecting Bad Spots on Magnetic Tapes

Some interesting information about bad spots on magnetic tapes was forthcoming during the discussion of this problem. The Univac people reported that in virtually all cases when there actually was a bad area on the magnetic tape, it could be found by visual inspection of the tape. This has been unlike the experience at some of the more recent 1103A installations where bad tapes have been blamed for some of the tape troubles and visual inspection has revealed no flaws in the tape whatsoever. In any case, it appears that a simple straightforward tape testing program whose primary job is to locate bad spot areas and allow them to be marked with a punch should certainly be in the repertoire of Remington Rand maintenance routines. The Program Development Committee will recommend to the Policy Committee that Bob Schmidt's Programming Group at St. Paul be requested to make this program one of the first that they produce in their battery of new machine diagnostic and maintenance programs. Some additional information on the bad spots problem and its solution was also forthcoming. It appears that bad spots can be punched in the proper locations while the magnetic tape is actually mounted on the Uniservo. One installation described some instances of splicing tapes mounted on a Uniservo. Some of the Univac people said that when the engineers had said the tape trouble was due to a bad tape and when visual inspection of that tape revealed no flaws, they had found, invariably, the difficulty was not due to bad magnetic tape, but rather to the Uniservo itself. The members of the committee were quite interested in these revelations and agreed they would pass this information along to their engineers at the earliest possible opportunity.

Report of Sub-Committee on Mnemonic Interpretive Operation Codes

At the previous Program Development Committee meeting a sub-committee composed of Ramo-Wooldridge and Lockheed Missiles was appointed to study and make a recommendation for a series of mnemonic OP codes to be used and translated by the USE Compiler for instructions which were to be interpreted. Tom Dewey (ML) and Robert Perkins (RW) were the members of this sub-committee who were present at this Program Development Committee meeting. Copies of the suggested operation code in both octal and symbolic and the name of the operation from which the mnemonics were derived were submitted to the members of the committee present. Appendix B is a copy of this Report. It was pointed out by the Chairman of the Committee that it was not the purpose of the sub-committee to recommend a standard set of interpretive routines to be adopted by the USE Organization. Rather, the sub-committee recommends that the USE Compiler be modified so that it translate a line of coding with one of the unique three or four letter operation codes into a computer word whose left-most two octal digits are 14 and the next two octal digits are those indicated for that mnemonic operation in the OP code table. It was brought out that the USE Compiler cannot at the present time handle these OP codes except by use of the EQUALS operation equating the mnemonic operation code (as a tag) to an octal address whose left-most two digits are the octal equivalent indicated in the table. The USE Compiler will be modified to accept these mnemonic operation codes. The proposal was not further discussed, the understanding being that the members interested would take time to study the recommendation of the appointed sub-committee and consider further action on the report at the next session on the following morning.

Report on Unicode

Phil Desilets (RR) gave a report on the status of Unicode. Unicode is an algebraic coding system being developed by Remington-Rand in St. Paul for the 1103A computer. Desilets reported that the overall planning is 75% complete; the flow charting is 45% complete; the coding is 25% checked out. The code checking has been done so far by using the Serial 9 1103 at St. Paul with the tape commands being handled by a set of tape simulator routines. In the very near future, an 1103A will be regularly available for use at St. Paul and the code checking will be transferred to and thereafter continued on that machine. It was brought out by Desilets that the vocabulary used in Unicode is almost identical to that used by the AT3 algebraic coding system developed for the Univac 1 and 2 computers used by Remington-Rand in Philadelphia. There will not be two-way compatibility between AT3 and Unicode and their respective machines, however. A code which is to be run on the 1103A and which has been written in the AT3 language (primarily for the Univac) must be re-copied by a one-pass pre-edit program before it can be translated by the Unicode compiler for running on the 1103A. A similar process will modify a Unicode so that it can be translated to run on the Univac. This one-pass pre-edit routine reads from one magnetic tape and copies a slightly modified version onto a second magnetic tape. The inability to achieve complete two-way compatibility between these two algebraic coding systems is due to fundamental differences in some of the input-output equipment, particularly the supervisory control typewriter available on the Univac and in use by the AT3 algebraic coding system. One of the committee members present reported that he knew of one installation which had made a careful comparison of Fortran and Unicode and had reached the following conclusion: Unicode is somewhat more restricting in its rules and has somewhat less flexibility than Fortran. However, after its careful objective comparison, this organization believes that on the whole Unicode is better and if they were offered a free choice between the two they would choose Unicode. This is an interesting observation and represents, to the Chairman's knowledge anyway, the first time that a careful study of this type has been made between Fortran and Unicode.

Desilets (RR) said that a set of up-to-date preliminary specification on Unicode will be distributed to the members of USE through the normal channels not later than October 1, 1957. It was generally agreed that all members of USE would look forward with great interest to the opportunity to study the Unicode specifications.

Catalog of USE Programs

At the previous Program Development Committee meeting two methods of cataloging, namely the catagorical scheme and the lexicographical scheme, had been discussed at considerable length. The sub-committee reported at the previous meeting on their deliberations and recommended that the lexicographical scheme of cataloging be accepted. The Policy Committee did not accept this method of cataloging; consequently, the subject was still open at this meeting. After some discussion the following recommendation was made:

Recommendation: All USE programs shall be assigned a 6-character identification tag, the first two characters of which shall be the letter pair assigned to the originating installation. The originating installation shall assign the last four characters of the tag in any way desired. This 6-character tag shall then serve as identification of the subroutine within the USE Organization. The Executive Secretary of USE shall prepare a catalog of USE subroutines. The cataloging shall be done in accordance with the scheme outlined in Appendix C of this report. The Executive Secretary shall circulate an updated catalog to all members of the USE Organization at intervals determined by the Executive Secretary.

This recommendation was accepted by the Policy Committee.

Contents of Subroutine Writeups

The format and contents of subroutine writeups have been in the past done on the basis of a report submitted by the Standards Committee after one of the meetings early in 1956. This report did not make clear in all cases just exactly what the contents of each section of the writeup should contain. It has been called to the attention of the Program Development Committee that this deficiency exists. After considerable discussion about some of the details it was decided that the magnitude of the task was too great to be handled in full committee in the time allotted. Consequently, a sub-committee on subroutine writeups was appointed. The Chairman of the committee is Bernard Urban of the Operations Research Office (OR). Urban indicated that he would meet with other members of USE in the Washington area and submit to the Chairman of the Program Develpment Committee a report outlining their recommendations within 60 days of this USE meeting. The other USE members in the Washington area are Applied Physics Lab, Corps of Engineers, and Bureau of Census.

Card Output of USE Compiler Listings

Tantzen (HO) is working on a USE subroutine for producing card output from the USE Compiler symbolic output tape. The specifications for the subroutine are as follows.

1. The subroutine shall be in standard USE form.
2. The subroutine will read a USE Compiler side-by-side symbolic output tape and produce one or two cards which can be listed. The first card will be a straight translation of the first 80 characters from the output blockette. This will include the octal translation of the line of coding as well as the entire symbolic form of the line of coding except for comments. A second card, if desired, will contain the "Comments" in the right-most 40 columns.
3. The subroutine will have two parameters which may be contained in a single word. One parameter will specify the tape unit on which the listing tape is mounted; the other parameter will specify whether the first card only or both cards (as described above) are to be punched.
4. The writeup shall indicate what changes must be made within the subroutine to modify the card punch code table so that output listings will conform to the particular equipment used for listing cards.

Tantzen will have this routine finished before the time of the next USE meeting and will submit it through the regular channels.

Floating Point in the USE Compiler

It was brought out at the previous Program Development Committee meeting that subroutines are being written to be run on the machines which have built-in floating point. These routines are of sufficient value to other organizations to warrant special modifications in the USE Compiler to make it easily possible to assemble these programs so that they will in effect run correctly on machines which do not have built-in floating point. This would necessitate a modified version of the USE Compiler which would work somewhat along the following lines.

The USE Compiler, upon encountering an operation code which corresponded to one of the nine built-in floating instructions could take the following action. The floating point instruction itself would be replaced by three instructions the first of which might be a TU instruction and the second a TV and the third a return jump to the appropriate standard USE subroutine. The floating point instruction itself could be incorporated into the compiled region as a cell in the working storage area--if this were done the TU and TV would reference that instruction. In this way the appropriate parameters would be transferred into the USE subroutine, control transferred to it and the USE subroutine would be the proper one to exactly simulate the floating point instruction in question. Evidently this would require in effect nine standard USE subroutines to cover all the floating point instructions. This feature is not difficult to attain but is does necessitate having the different version of the USE Compiler. Perkins (RW) was unable to predict when such a version of the USE Compiler would be available, but he did agree that work would begin on it very soon.

Tantzen (HO) reported briefly on some work done at Holloman along these lines and submitted a one-page writeup briefly describing the scheme. This writeup is incorporated as Appendix D of this report.

Headings in the USE Compiler

There is a need to have the USE Compiler handle alphanumeric combinations without translating them at all. There are some difficult problems connected with this and any solution allowing characters of this type to be written as an integral part of the USE Compiler code would of necessity be awkward in some cases. Perkins described one possible solution as follows: A new operation code would be added to those understood by the USE Compiler. This operation code would introduce so-called headings. The remainder of that instruction would constitute six characters of a heading word. Those characters which either do not show in the print or which do have special significance to the compiler (examples are space, end of line symbol) would be handled by a character pair, the first of which would be a character only rarely needed in headings and a character which has no significance to the compiler. The rule would be then that such a character pair would be treated as a single alphanumeric character and each unique pair would have a unique six bit translation.

Another suggestion was that headings be handled exclusively by USE subroutines perhaps by reading the headings in by cards or another magnetic tape. This problem will be investigated more fully by Ramo-Wooldridge and reported on in the next Program Development Committee Meeting.

Standardized Alarm Exit

This question was brought us by Bauer (WF) and after discussion a scheme proposed by him was adopted by the committee to be a recommendation to the Policy Committee. The recommendation is as follows:

Recommendation: The name of the subroutine shall be the 6-character name assigned by the originating installation, the first two characters of which are the letter pair assigned to that installation. The instruction in the alarm exit shall be a return jump to an alarm routine as determined by each installation. Upon detection of an alarm condition within the subroutine the flexowriter coded name of the subroutine shall be placed in Q immediately before jumping to the alarm exit of the subroutine.

This recommendation was accepted by the Policy Committee.

Los Angeles Information Exchange Meeting

Time did not permit the Program Development Committee to discuss this subject. However, it was discussed to a certain extent in the General Session.

The Program Development Committee will meet again at the next regular USE Meeting to be held in Dallas, Texas, on the last three days of the week in November preceding the week of Thanksgiving.

Respectfully submitted,

Donn Combelic

Donn Combelic, Chairman
Program Development Committee

APPENDIX A

Program Development Committee Attendance

D. Armstrong	BC
F. Bauer	WF
D. Beaver	RR
C. Bitterli	AP
R. Carriker	BA
G. Clark	OR
D. Combelic	RW
H. Dahlbeck	RR
P. Desilets	RR
T. Dewey	ML
H. Fitzgibbon	RR
D. Heiser	BC
L. Kennedy	RR
L. Laure	CE
M. Lieberknecht	BA
B. Mittman	RR
R. Perkins	RW
R. Petonke	CE
G. Pyle	White Sands P. G.
R. Rich	AP
R. Schmidt	RR
R. Spence	Stanford Research Inst.
J. Steele	Arnold Engineering Development Center
A. Stone	AP
R. Tantzen	HO
B. Urban	OR
E. Wendt	BC

APPENDIX B

BASIC OPERATIONS

OCTAL	NMEMONICS	FUNCTION
00	LDR	Load Result Storage
01	LFR	Load F and R
02	ADD	Add
03	SBT	Subtract
04	MPY	Multiply
05	MPA	Multiply Add
06	PMP	Polynomial Multiply
07	DIV	Divide
10	SQR	Square Root
11	SIN	Sine
12	COS	Cosine
13	EXP	Exponential
14	LOG	Logarithm
15	ATN	Arctangent
20	STU	Store Unrounded
21	BTU	Block Transfer Unrounded
22	FIX	Floating to Stated
23	FLT	Stated to Floating
24	STR	Store Rounded
25	BTR	Block Transfer Rounded
77	NOP	No Operation
76	LBB	Locate B-Boxes
16	CIP	Conjugate Inner Product
17	NIP	Non-conjugate Inner Product
26	LDP	Load Positive
27	LDN	Load Negative
66	LDM	Load Magnitude
67	ADM	Add Magnitude

MATRIX OPERATIONS

OCTAL	MNEMONICS	FUNCTION
30	MADD	Add
31	MSBT	Subtract
32	MMPY	Multiply
33	MTRM	Transmit
34	MTRP	Transpose
35	MINV	Inverse
36	MSMP	Scalar Multiply
37	MDAD	Diagonal ADD
40	MSPR	Spur
41	MDET	Determinant
42	MROW	Row Select
43	MCOL	Column Select
44	MPAR	Partition
45	MRPL	Replace
47	MSET	Bank Set

DOUBLE PRECISION OPERATIONS

OCTAL	MNEMONICS	FUNCTION
50	DLDR	Load Result Storage
51	DLFR	Load F and R
52	DADD	Add
53	DSBT	Subtract
54	DMPY	Multiply
55	DMPA	Multiply Add
56	DPMP	Polynomial Multiply
57	DDIV	Divide
60	DSQR	Square Root
61	DSIN	Sine
62	DCOS	Cosine
63	DEXP	Exponential
64	DLOG	Logarithm
65	DATN	Arctangent
70	DSTU	Store Result Unrounded
71	DBTU	Block Transfer Unrounded
72	DFIX	Floating to Stated
73	DFLT	Stated to Floating
74	DSTR	Store Result Rounded
75	DBTR	Block Transfer Rounded

H. Operations Research and Linear Programming

I. Input

1. Binary
2. Octal
3. Decimal
4. Composite

J. Output

1. Binary
2. Octal
3. Decimal
5. Analog
9. Composite

K. Executive Routine

1. Assembly
2. Compiling

L. Information Processing

1. Sorting
2. Conversion
3. Collating and Merging

M. Debugging Routines

1. Tracing
2. Dump
3. Search
4. Breakpoint Print

N. Simulation Programs

1. Peripheral Equipment Simulators

O. Diagnostic Programs

P. Service Programs

1. Clear, Reset Programs
2. Check Sum Programs
3. Restore, Rewind, Tape Mark, Load Button Programs

Z. All Others

APPENDIX C

SUGGESTED CATALOG CLASSIFICATION FOR USE ROUTINES

A. Programmed Arithmetic

1. Real
2. Complex
3. Decimal

B. Elementary Functions

1. Trigonometric
2. Hyperbolic
3. Exponential and Logarithmic
4. Roots and Powers

C. Polynomials and Special Functions

1. Evaluation of Polynomials
2. Roots of Polynomials
3. Evaluation of Special Functions

D. Operations on Functions and Solutions of Differential Equations

1. Numerical Integration
2. Numerical Solutions of Ordinary Differential Equations
3. Numerical Solutions of Partial Differential Equations
4. Numerical Differentiation

E. Interpolation and Approximations

1. Table Look-up and Interpolation
2. Curve Fitting
3. Smoothing

F. Operations on Matrices, Vectors and Simultaneous Linear Equations

1. Matrix Operations
2. Eigenvalues and Eigenvectors
3. Determinants
4. Simultaneous Linear Equations

G. Statistical Analysis and Probability

1. Data Reduction
2. Correlation and Regression Analysis
3. Sequential Analysis
4. Analysis of Variance
5. Random Number Generators

APPENDIX D

Floating Point Arithmetic for Computers
with and without the Floating Point Hardware

The "Minimum 1103A" does not comprise the built-in floating point package. Programs with floating point arithmetic therefore will use an interpretive routine. Installations with the package will usually use the floating commands. Some installations may get their floating point package later and do not want their old programs to become obsolete.

The obvious answer to this problem is to write all programs with the floating commands and let the symbolic translator (compiler, Trans-Use) automatically supply an interpretive routine which exactly simulates the floating point hardware.

While working on this problem, Holloman came to the conclusion that a reasonable compromise would be a good solution. Considering the facts that (1) A large percentage of floating arithmetic will be done in single precision only, and therefore, (2) Only rounded and packed results are wanted most of the time, it was agreed to simulate only the 6 arithmetic commands FA, FS, FM, FD, FP, FI. These commands may also be repeated, just as in the built-in package. Restriction to these commands meant saving space and execution time.

Assuming that the "Trans-Use" service routine will be used to translate and assemble the symbolic program, the procedure to write a program is as follows:

1. Write the program as if you had a machine with floating point hardware.

2. Before the occurrence of the first floating command insert a command: TP K 00001, where the constant K is MJ 0 HOFS11. (HOFS11 is the name of the Holloman floating point interpretive routine.) This will activate the routine, i.e., cause it to be assembled and place a proper jump in 00001.

3. Preceding each group of commands containing floating commands insert an extra command: IP N RETURN, where N is the number of commands in that group and RETURN specifies where to continue after the group has been executed, which usually will be the next command in line after the group.

To make such a program work on a machine with floating point,

a. Remove commands as specified under 2 and 3 and retranslate,

or

b. Replace those commands by dummies in the absolute assembled version of the program, whichever is easier to do.

R. G. Tantzen

Talmadge

UNIVAC SCIENTIFIC EXCHANGE
Dallas Meeting 20-22 November 1957
Policy Committee Minutes

The Policy Committee at the Dallas meeting consisted of:

Bob Rich (AP) Chairman
Dirk DeVries (RR) Executive Secretary
John Spencer (CE)
Donn Combelic (RW)
Don Heiser (BC)
Demetrius Zonars (WF)
Lucille Graham (WS)
Marvin Green (HO)
Tom Dewey (ML)
George Clark (OR)
Bob Schmidt (RR)
Alex Stone (AP)

Item 1. New Members.

White Sands (WS) applied for voting membership and, since the requirements were met, was accepted.

Since the last meeting three new non-voting members had been accepted: the Bureau of Internal Revenue, American Bosch Arma, and Arnold Engineering Development Center. At this meeting the Flight Simulation Laboratory at White Sands (distinct from the White Sands voting member) was accepted as a non-voting member.

Systems Programming, Los Angeles, had applied for non-voting membership, and was rejected at this meeting.

Item 2. Approval of Minutes.

The Policy Committee Minutes of the last meeting were approved.

Item 3. Agenda.

The Agenda for the present meeting, as approved, is enclosed as Appendix A of these minutes.

Item 4. Action on Committee Reports of Last Meeting.

No action necessary.

Item 5. Common Language.

A group of central European mathematicians wrote a letter to Professor John W. Carr, III suggesting a European meeting on the subject of common machine languages and inviting Carr to take the initiative in assembling an American delegation to attend. Carr circulated this letter under a covering memo to a number of organizations. He suggested that the American delegation consist of six people - himself, Alan J. Perlis, someone from MIT, and one person each from the IBM, Remington Rand and Datatron groups.

Specifically he requested that USE, in consultation with Mr. Porter of Boeing, Dr. Bauer of Ramo Wooldridge, and the Remington Rand Univac Division (the groups of Dr. Hopper and Dr. Mauchly) choose one representative.

During the Policy Committee discussion of this communication the following feelings developed: 1) that USE was interested in this common language effort and wanted to cooperate; 2) that the interests of commercial and governmental users of machines should be taken into account in the composition of the delegation.

It was moved by Combelic and seconded by Spencer that Tom Dewey (ML) represent USE in choosing a delegate according to the mechanism described in Carr's memo. Motion carried with 9 ayes and one abstention.

It was moved by Schmidt and seconded by Stone that in this negotiation Dewey should propose Rich as the USE nominee. Motion carried unanimously.

The Chairman was directed to reply to Carr's communication, giving the sense of the meeting.

It was moved by Green and seconded by Heiser that working committees on the east coast (Rich, chairman) and on the west coast (Tantzen, chairman) convene before the European meeting to explore USE interests in the common language, and that Rich circulate to each organization an agenda for these meetings.

Motion carried unanimously.

Item 6. Training Committee.

In view of the advantages of mutual assistance in the training required to use the 1103A to best advantage in each installation, it was decided to form a training committee with Dorothy Armstrong (BC) as chairman. She was requested to circulate a letter to USE members asking for any training materials available and for designation of committee members.

She may call such meetings as seem desirable to survey the available materials and form a clear picture of what is needed.

The Training Committee will meet on the first day of the next USE meeting (the day before the General Session) to develop a specific proposal.

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Item 7. Next Meeting.

The next USE meeting will be in Washington, D. C., 26-28 March 1958. The Policy and Training committees will meet on the 26th and the General Meeting will occur on the 27th and 28th.

The following meeting is scheduled for San Francisco, 30 July - 1 August 1958.

Item 8. Publication of USE material by RR Sales.

Reference is made to Paragraph 7.5 of the Revised Statement of USE Policies, 24 July 1957, which authorizes the Executive Secretary to make available to RR Sales, to use as they see fit: membership lists of the USE organization, specifications and descriptions of routines which are available to members of USE, and such other items as the Policy Committee may from time to time direct.

RR Sales requested a clarification of policy concerning their use of papers presented at USE meetings.

It was moved by Green and seconded by Heiser that: USE encourages RR Sales to request from authors and their organizations permission to publish papers presented at USE meetings.

Motion carried unanimously.

Item 9. Mod. II Uniservos

Schmidt (RR) discussed the status of the Mod. II Uniservos and plans for their incorporation into 1103A systems.

Item 10. Programming Manual.

The advisability of a Summary section of the Programming Manual was pointed out. The need for plenty of copies at each installation was emphasized.

Item 11. Overflow Stop.

Dewey (ML) emphasized the desirability of having the machine trap on overflow rather than stop as it now does. Schmidt (RR) will get a new price for this feature by the next meeting.

Item 12. Catalog.

Remington Rand was strongly urged to put out the catalog of USE routines without further delay. This catalog should be revised within one month of each USE meeting.

Item 13. Binary Clock.

This item was referred to the Installation Operations Committee for drafting of a proposal.

Item 14. Minimum USE Machine.

This item was deferred to the next meeting.

Item 15. Remington-Rand non-engineering contribution to USE.

The compiler is being temporarily modified to permit checkout on Serial 9.

The following were suggested as appropriate lines of further RR programming effort as manpower becomes available: 1) Matrix package, 2) Common language translator, 3) Sort and merge routines, 4) Machine operating system, 5) Double precision input routines, 6) Test routines.

Item 16. Covering Letters.

Every USE distribution should have a covering letter containing a serial number and a description of the matter distributed.

A page number is assigned to each page of USE material by RR. This page number will be reproduced, in future, on the distributed copies.

Item 17. Work in Progress Report.

It was moved by Combelic and seconded by Dewey that the Executive Secretary send to each installation, one month prior to each USE meeting, a form for reporting unclassified work in progress. Combelic will design such a form. The completed forms are to be presented and distributed (without prejudice) at the meeting.

Motion carried unanimously.

Item 18. Action on Mathematics Committee Report.

The Mathematics Committee recommended that: 1) additional distribution be made of its minutes and accompanying papers to provide copies for committee members; 2) the topic for the next meeting be Integral Equations; 3) Remington Rand be encouraged to provide USE standard programs for linear programming, multiple regression, and integration by Gaussian quadrature. These recommendations were approved by the Policy Committee.

The Mathematics Committee is also requested to investigate double precision floating point common function subroutines.

Item 19. Action on Program Development Committee Recommendations.

The committee proposal for a standard subroutine format was approved unanimously.

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It was moved by Stone and seconded by Spencer that the proposed letter on the 436 microseconds between successive reads and writes be sent to RR. Carried with 10 ayes and 1 abstention.

It was moved by Schmidt and seconded by Green that the Chairman sign one copy of this letter for the organization rather than that each installation sign a copy. Carried with 9 ayes and 1 nay.

The question of whether this change in procedure will be permanent was deferred to the next meeting.

It was moved by Combelic and seconded by Stone that the Chairman sign for the organization the proposed letter on the 35 millisecond delay. Carried with 8 ayes, 1 nay, 2 abstentions.

Item 20. Action on Installation Operations.

Committee Report

Policy Committee action on Items 1 and 5 concerning logging procedures and time reporting to USE was deferred to the next meeting.

The recommendations of the committee on item 2 (list of peripheral equipment by organization), item 3 (RR report at next meeting on possible remedy for Ferranti fault indication during normal operation), item 7 (use 4 interlace for new maintenance routines), item 8 (RR investigate switch to bypass typewriter), and item 9 (RR investigate program clock) were approved by the Policy Committee.

Respectfully submitted,

R P Rich

R. P. Rich
Chairman

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APPENDIX A

UNIVAC SCIENTIFIC EXCHANGE

Agenda for Dallas Meeting
21-22 November

A. Policy Committee

1. New members
2. Approval of minutes
3. Set Agenda
4. Action on Committee reports of last meeting
5. Common language
6. Training committee
7. Time and place of next meeting
8. Publication of USE material by RR Sales
9. Mod 2 Uniservos
10. Programming manual
11. Overflow stop
12. Catalog
13. Binary clock
14. Minimum USE machine
15. RR non-engineering contribution to USE
16. Covering letters

B. General Session

1. Announcements
2. Reports of Committee Chairmen
3. Report on peripheral equipment
   a) New card reader
   b) Card to tape converter
   c) Uniservo II
   d) Buffers
   e) Tape to card
4. Status of machine modifications

C. Installation Operations Committee

1. Machine logging procedures
2. Attachment of peripheral equipment:
   a) reporting form
3. Policy on fault circuitry
4. Variable block
5. Time reporting to USE
6. Dead space storage
7. Status of new maintenance routines
8. Switch to bypass typewriter
9. Binary clock

D. Program Development Committee

1. Common language
2. Status of coding assignments
3. Double precision arithmetic
4. Report of subcommittee on subroutine writeup
5. Headings in the USE Compiler
* 6. New magnetic tape times
7. Decimal card in-out routines in compiler form
8. Compilation of FP instructions
9. FP package in compiler form
10. Compiler service system
11. Service library reports
12. Remote code checking
13. Unicode on non-floating point machines

E. Mathematics Committee

1. Ordinary differential equations
2. Status of coding assignments
3. Suggestions for RR assistance

Talmadge

USE Letter No: PC - 8
NV - 4

January 6, 1958

To: USE Policy Committee, Publications Committee, Installation Heads

Enclosed herewith are the Minutes of the November 21 - 22, 1957 USE Program Development Committee.

Dirk de Vries

Dirk de Vries
Executive Secretary, USE
Remington Rand Univac,
Univac Park,
St. Paul 16,
Minnesota.

932 - 941

DdV:diw

Enc.

Talmadge

January 4, 1958

To Members of USE:

There is a typographical error on Page Two of Appendix D to the Report of the Program Development Committee at the Dallas USE meeting. The second paragraph describing the "TEMPS" control line should be in agreement with the Compiler Programming Manual. The paragraph should read as follows:

> A "TEMPS" control line is used to indicate to the compiler what part of the subroutine temporary pool in the compiled region is to be used by the subroutine. The u address field contains an integer which is equal to the number of consecutive cells used by this subroutine in the temporary pool. The v address field contains an integer which is equal to the number of cells to be left at the beginning of the temporary pool ahead of those used by this subroutine. These may be temporaries used by subsidiary subroutines. If either address field is blank, the corresponding quantities are taken to be zero.

Sincerely yours,

Donn Combelic

Donn Combelic, Chairman
Program Development Committee

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:jm

USE ORGANIZATION MEETING

November 21 and 22, 1957

Dallas, Texas

Report of the Program Development Committee

The Program Development Committee met Thursday morning, November 21, from 10:30 to noon and from 1:30 to 5:15 and again on Friday morning, November 22, from 9:00 til noon. Appendix A contains a list of the persons attending one or more of the meetings.

Agenda

The Policy Committee recommended the following items for the agenda of the Program Development Committee:

1. Common Language
2. Status of coding assignments
3. Double precision arithmetic
4. Report of sub-committee on subroutine writeup
5. Headings in the USE Compiler
6. New magnetic tape times
7. Decimal card input/output routines in compiler form
8. Compilation of the floating point instructions
9. Floating point package in compiler form
10. Compiler service system
11. Service library reports
12. Remote code checking
13. UNICODE on non-floating point machines

The following items were added to the agenda of the committee:

1. Work in Progress reports
2. Non-mathematical routines which can be done by Remington Rand

The items on the formal agenda were all covered, but in some cases with the subject matter somewhat different. Consequently, the main headings of the subjects covered in the committee are different from those on the formal agenda.

USE Compiler and Related Subjects

Robert Perkins (RW) reported on modifications to the USE Compiler since the last USE meeting and other USE Compiler subjects.

The interpretive operation codes agreed upon by the USE Organization at the previous meeting have now been incorporated into the USE Compiler. The changes necessary to include this translation feature will be distributed in the form of a binary correction deck which will also include corrections of minor errors which have been found in the meantime.

Some installations have requested a version of the compiler which would do the following: replace (during compiling) each 1103A floating-point instruction with a calling sequence, and then incorporate automatically one copy of each appropriate subroutine which would carry out the floating-point arithmetic using fixed-point instructions only. This requires a major change to the compiler and is of importance to only a few installations on a limited basis. Ramo-Wooldridge is not able to make this modification because of time and manpower limitations. If it is to be made, it will have to be by some other installation.

Ramo-Wooldridge agreed to modify the USE Compiler so that it could use relocatable binary subroutines from a library tape. It is expected that this modification will be completed by the time of the next USE meeting and would be made available in the form of a new self-contained binary deck of the entire compiler. The subroutine library maker associated with this modification will be able to add any number of subroutines to the library tape at one time.

The problem of incorporating excess 3 information directly into the USE Compiler was again discussed. Ramo-Wooldridge agreed to incorporate a feature allowing direct input of excess 3 information in the USE Compiler. It is expected that this modification will be completed by the time of the next USE meeting.

The USE Compiler subroutine library maker has been modified to do its read back check on all biases rather than on normal bias only. This will solve some serious operational problems which have arisen at installations using the routine in question. The problem of how to restart after a tape parity failure was discussed. An option will be provided so that the operator can either try the failing block once more or skip that block and continue with the compiling.

Operating Systems and Related Programs

George Toal (CE) reported on the operating system developed for CE. It is named GOOFUS, Generalized Operational Organization For Univac Scientific. Toal passed out writeups of this system to all persons concerned and indicated that additional writeups could be obtained by merely writing to him at the Corps of Engineers. He pointed out that this operational system is designed for their particular installation where programs once checked out may be run many, many times over a period of several months without change. The emphasis is to provide a system which will yield maximum efficiency under this kind of operating. At the present time, code check runs at the Corps of Engineers vary from fifteen minutes to an hour duration and the operating is done by programmers. CE expects to hire operators in the near future.

Peter Pastoriza (OR) had with him three copies of the writeup of the OR operating system. The copies were circulated for inspection and the system described briefly by Pastoriza. As soon as formal approval for release of the writeup has been obtained, copies will be sent to all USE members.

Tom Dewey (ML) described the outlines of the DUFF operational system to be installed by Lockheed in early 1958. At that time, Lockheed will have a second 1103A with built-in floating point as well as card-to-tape and tape-to-card converters. The DUFF operational system is built around the availability of these two pieces of equipment. The objective of the system is to obtain almost completely automatic operation of the computer over a long period of time and also to provide powerful automatic diagnostic facilities. Dewey expects that writeups of the system will be available within a few months.

Donn Combelic (RW) reported on an output conversion system now being used on a limited basis at Ramo-Wooldridge. The system incorporates the salient features of the output conversion scheme used by the 704 Monitor System. Within the program producing the output is incorporated a small simple subroutine which dumps information on magnetic tape in binary along with certain control words provided by the programmer. At the end of the run the tape is rewound and the Output Processor program is called in to convert to binary information to listable output according to the control words. The Output Processor system in use at Ramo-Wooldridge is described in detail in Appendix B.

Remote Code Checking

George Toal (CE), among others, is interested in receiving information from installations which do code checks and production runs without the presence of the programmer. Installations having this kind of operation were asked to communicate with Toal directly, outlining the features of their operational system including sample forms, qualifications of computer operators, any reports on the operation of the system, etc.

Double Precision Arithmetic and Floating-Point Packages

There were inquiries about the availability of double precision arithmetic floating-point packages. Ramo-Wooldridge announced that they now have checked out four interpretive packages as follows: single precision real, double precision real, single precision complex, double precision complex. All of these assume built-in floating-point in the computer and are written as standard USE subroutines in compiler language. The writeups and coding of these routines will very soon be submitted to the Executive Secretary of the USE Organization. The only built-in floating-point instruction used is the unpack instruction. Because of this, the routines can be easily modified to run on machines which do not have built-in floating point.

Double Precision Elementary Functions

Some organizations are interesting in obtaining subroutines for computing certain elementary functions in double precision floating point. There appeared to be little available along these lines at the present time among the various organizations. As a result, it was recommended to the Policy Committee that the Mathematics Committee make a survey of the availability of such routines and, in addition, look into the possibility of producing routines which are not already available. The Policy Committee has so recommended and it is expected that a report on this will be forthcoming at the next USE meeting from the Mathematics Committee.

Status of Coding Assignments

The last uncompleted coding assignments were those from Ramo-Wooldridge for five of the common functions, namely, arctangent stated and floating point, exponential stated and floating point, floating point sine and cosine. These routines have been completed and the writeups and coding were submitted and will be made available through the regular channels. No other coding assignments had been made.

Subroutine Writeups

At the previous USE meeting a sub-committee consisting of members of OR, AP, BC had been appointed with Bernard Urban (OR) as chairman to make recommendations to the USE Organization on a standard USE program writeup format. This committee did come up with a recommendation which was circulated to all USE members several weeks before this USE meeting thereby giving each member sufficient opportunity to study the recommendation. As a result of considerable discussion on the subject, the format proposed by the sub-committee was re-examined and a compromise format was agreed upon. It was recommended to the Policy Committee that this compromise format be accepted as the standard USE routine writeup form. This recommendation was accepted and the standard writeup form is attached as Appendix C of this report. This writeup format is to be followed for all routines submitted to the USE Organization for circulation to the member organizations. Routine writeups which do not follow this form or are non-standard in other respects should continue to be submitted as USEful Notes. One of the purposes of the new writeup format is to allow programs other than subroutines to be written up in the same form. The hope was expressed that the writeup form would be such as to encourage organizations to submit writeups of programs which have not previously been submitted because of the more stringent requirements on standard subroutines in the past.

Compendium of USE Routine Standards

In addition to its work described above, the sub-committee on subroutine writeups compiled all published information about USE subroutine standards. Ramo-Wooldridge agreed to sift this information and provide an up-to-date correct writeup. This has been done and the report is attached as Appendix D, "Conventions for USE Routines."

New Magnetic Tape Times

Previous literature available to 1103A users had given 436 ms as the maximum allowable time between magnetic tape reads or writes. At least one installation now has working several programs which make full use of this published allowable time. In early November, Remington Rand completed the first manuscript copy of a new Programmer's Manual for magnetic tapes. In this manual the safe times quoted as available between magnetic tape reads and writes was given as 350 microseconds. If this shorter time is adopted as standard by Remington Rand and adhered to by their field maintenance engineers, the programs previously mentioned would no longer work. The change of specifications described here obviously has serious implications for the installation in question. However, the issue soon became far larger than inconvenience to one installation and was seized upon by several of the committee members as illustrating an important matter of principle. It was decided that a letter on this subject be composed and sent officially to Remington Rand from the USE Organization. John Spencer (CE) and Leonard Fall (WF) were appointed as a sub-committee to compose a suitable letter on this subject. As the discussion progressed, representatives of the Bureau of Census observed that a somewhat different problem with respect to change in specifications had arisen concerning the additional 35 milliseconds lockout of magnetic tape units between blocks when reading or writing in the block-by-block mode. A second letter by Don Heiser (BC) and Dorothy Armstrong (BC) was composed on this subject for transmission to Remington Rand by the USE Organization. The letters were both accepted without change by the USE Policy Committee and will be transmitted to Remington Rand as communications from the USE Organization. Texts are available in the minutes of the USE Policy Committee.

Decimal Card Input/Output Routines

R. G. Williams (OR) described some work which they are doing on decimal card routines. They are re-coding two Convair routines, CV-130 and CV-131, in USE Compiler language for running on the 1103A. These routines are both stated-point decimal card routines -- the first for reading, the second for punching. They will be distributed through the normal channels after the meeting. Combelic (RW) described a generalized card read-in routine which has now been completed at Ramo-Wooldridge. This is written up in standard USE subroutine form and will be made available through the normal channels. Tantzen (HO) described a set of routines developed by Holloman for decimal cards. They are input and output routines which will handle floating or stated point numbers, six numbers per card with the same format on both input and output.

Reports on Work In Progress

It had been suggested in the Policy Committee meeting that the member organizations would very probably benefit considerably from knowing the existence and status of various projects at other installations. A reporting system was suggested in which each installation would be sent a "Work in Progress Report" form approximately one month before each USE meeting. This form would be standard for all installations and would provide space for a very brief description of the problem or program under consideration or being worked on and a column in which to indicate the stages in which such work is. The representative of each installation would fill out the descriptions and the status column, indicating the highest state of progress on this problem. It was suggested that the chairman of the Program Development Committee compose a covering letter to accompany the first mailing of these forms by the Executive Secretary. Subsequent mailings of the form would be on a routine basis and each member installation would be expected to fill out the form approximately one month before each USE meeting. The completed form would then be returned to the Executive Secretary of USE, who would reproduce and distribute copies to all member organizations before the next USE meeting. The details of this procedure, as well as a sample form, are included as Appendix E of this committee report.

Routines for Development by Remington Rand

Bob Schmidt (RR) announced that from time to time experienced programmers were available at Remington Rand for new programming projects. In many cases the particular problem which these people can solve is not definitely decided. In order to make this group of programmers of more value to the USE Organization, Schmidt requested that the USE Organization make available a list of rather major projects which they would like to see developed. Selections would then be made from this list by Remington Rand whenever programming manpower was available for the project. A list of such routines was prepared in committee and given below. The programs are arranged in order of decreasing importance as determined by the committee.

1. Matrix package
2. Common language translator
3. Generalized sort and merge
4. Operating system (incorporating best features of existing systems)
5. Generalized input routine, including double precision floating-point input
6. Machine test routines

Bob Schmidt (RR, St. Paul) presented to the committee a request from Remington Rand for aid in their Product Planning Department along the following lines. In order bette:

to design new computers, Remington Rand would like to know the characteristics of present major areas of application at each installation and of applications which have been found impractical for one reason or another. They also would like to know the characteristics of applications which are presently only being considered or are limited but promise to grow. The full written request as formally presented by Schmidt is attached as Appendix F. Except for two installations where virtually all work is classified, full cooperation was promised. It was agreed that Remington Rand would take the lead in obtaining the actual information, but that each member would prepare for such a request by making a preliminary survey at his installation as soon as practicable

Alarm Routine

Leonard Fall (WF) reported that they have written up a relatively simple alarm routine to work with their operational system. Interest was expressed in this by some of the committee members and Wright Field will circulate the writeup of their program either as a standard USE routine or as a USEful Note in the near future.

Report on UNICODE

Phil Desilets (RR) reported on progress on UNICODE at St. Paul. UNICODE is being done for 1103A computers with built-in floating point. It is expected that this version of UNICODE will be finished by June of 1958. After this is done, the programming group working on UNICODE intends to produce a modified version for non-floating point machines This modified version will use an interpretive floating point system for handling the floating point arithmetic. Considerable interest in this project was expressed by several of the committee members and it is hoped that the June 1958 completion date can be realized.

Universal Language

Bob Rich, Chairman of the USE Organization, received during the early part of November a communication from Dr. John W. Carr, President of ACM, concerning a projected meeting in Central Europe on a universal computer language. The Policy Committee took certain action on this proposal which involves the USE Organization. During the discussion in the Policy Committee it was pointed out that if the European meeting does in fact produce the specifications for a universal computer language, the USE Organization should be in a position to move quickly to take advantage of these proposals and to provide, as soon as practicable, a working translation program for the 1103A computer. In addition, it was brought out that any person representing the USE Organization, either wholly or in part, might very well benefit from having at his disposal a set of ground rules or recommendations prepared by prospective users of such a universal language. As a result of these discussions the Policy Committee recommended that two working committees, one for the West Coast and one for the East Coast, be set up and begin to work in the very near future toward these various objectives. Four broad items were suggested for consideration by such a working committee. Briefly stated, they are as follows:

1. Collection of experience of members either with systems having features which might be available in a universal computer language or features recommended as desirable by various members of their organizations over the past few years.

2. Evaluation of present existing algebraic coding or similar systems and the time required to code and check out the translation program on any given machine

3. To look into possible implications of a universal language on the internal computer operations of the member organizations.

4. To investigate and attempt to reach decisions on certain systems considerations which would necessarily be involved if a desirable universal language is indeed forthcoming from the European meeting. Examples of decisions of this type which could be made even before the specifications of the language are known are; should the language be translated directly from the input form to machine language or should it pass through a secondary language, how would input and output be handled and specified within the framework of any given operational system, what method of communication of programs could be used between various organizations, etc.

No attempt was made in the Program Development Committee to do much more than mention the items indicated above which might be profitably considered by the universal language working committees. There seemed to be a fair amount of agreement that such a committee could perform some valuable work before the European meeting, which is to be held in late February. Further discussion was limited by press of time and the main reason for reporting these occurrences in this report is to remind the member organizations of some of the implications of the availability of a common language and what thoughts they might be giving to this matter before the first meetings of the working committees.

Respectfully submitted,

Donn Combelic, Chairman
Program Development Committee

APPENDIX A

Program Development Committee Attendance

Dorothy Armstrong	Bureau of the Census, (BC)
Marvin Bass	Remington Rand, Washington, D.C., (RR)
Donn Combelic	Ramo-Wooldridge, (RW)
Philip Desilets	Remington Rand, St. Paul, (RR)
Tom Dewey	Lockheed Missile Systems, (ML)
R. K. Draving	Remington Rand, St. Paul, (RR)
Leonard Fall	Wright Air Development Center, (WF)
Ruth Kamena	Remington Rand, Dallas, (RR)
Gene Kottler	Internal Revenue Service
Paul Medley	Remington Rand, Alamogordo, (RR)
Betty Mitchell	Bureau of the Census, (BC)
Sig Olson	Remington Rand, Detroit, (RR)
Peter Pastoriza	Operations Research Office, (OR)
R. Perkins	Ramo-Wooldridge, (RW)
Lloyd H. Rhodes, II	Holloman AFB, (HO)
Conway Sams	Lockheed Missile Systems, (ML)
Gerald Sieracki	Remington Rand, St. Paul, (RR)
Alexander G. Stone	Applied Physics Lab, (AP)
Robert G. Tantzen	Holloman AFB, (HO)
George Toal	Corps of Engineers, (CE)
E. L. Wendt	Bureau of the Census, (BC)
R. G. Williams	Operations Research Office, (OR)

November 15, 1957

APPENDIX B

THE RAMO-WOOLDRIDGE CORPORATION
Los Angeles 45, California
Digital Computing Center

A SYSTEM OF OUTPUT ROUTINES FOR THE 1103A

General Description

The system described here provides for data output on magnetic tape for listing on the off-line high-speed printer.

In a program written in USE Compiler language the programmer calls for certain of the output subroutines described below. (These are standard USE subroutines and are normally called for by means of a line of coding which produces a calling sequence.) These output subroutines record on uniservo number three in binary form the data words along with certain control words which specify the type of numbers and the format in which the output is to be edited. After one or more runs have been completed a systems routine, the Output Processor, is brought in. The Output Processor is a combined conversion and editing routine which reads in the binary data tape, converts and edits the data according to the control words on the tape, and writes the output in listable form on another tape.

Output Subroutines

There are two basic types of output routines: the format control routine, RWF1; and the print or dump data routines including RWP1, RWD1, RWD2, and RWD3. The format control routine and at least one of the print or dump data routines should be included in each program. The format control routine contains the common output hopper which is used by each of the print or dump routines as well as by the format routine itself.

To produce data in a particular format the format routine is entered with the number of the desired format as the argument. For example, to specify format number 33 write:

```
    ,    ,    RWF1,    L(33)    ,    ,    $
```

The format number is placed on the magnetic tape as a control word.

The data words required by the specified format number are then written on the tape by appropriate entires to the print or dump data routines. An entry to the print routine, RWP1, puts one data word, its argument, on magnetic tape. Each entry to one of the dump data routines RWD1, RWD2, or RWD3, puts a number of data words on tape. The number of words dumped is given implicitly by the argument which specifies the region to be dumped. In particular, RWD1 simply dumps the region specified by the argument, RWD2 puts the argument itself as well as the region it specifies on tape, and RWD3 dumps the specified region and then clears that region to zero.

The specification of a particular format number predetermines the pattern of the data words that are to follow, but not, in general, the total number of data words. For example, format number 33 designates a particular three column floating point format. Therefore, three data words are required to produce each line of output. Any number of groups of three data words may follow the format control word. It is not necessary to repeat the format control word for each line as long as the format is to remain the same. The processor will, in this case, produce a line of three floating decimal numbers for each three data words until a new format control word is encountered.

A section of coding using this particular format might be as follows:

```
  ,        ,          RWF1,      L(33),          ,         $
  ,   Loop,            :
  ,        ,          RWP1,      X    ,          ,         $
                       :
  ,        ,          RWP1,      Y    ,          ,         $
                       :
  ,        ,          RWP1,      Z    ,          ,         $
                       :
  .        .          IJ   ,     Index,     Loop,          $
                       :
```

Another way to achieve this result would be:

```
  ,        ,          RWF1,      L(33),          ,         $
                       :
  ,   Loop,            :   ,          ,          ,         $
  ,        ,          RWD3,      Range,          ,         $
                       :
  ,        ,          IJ   ,     Index,     Loop,          $
                       :
  ,  Range,           00   ,     Hopper,Hopper+2,          $
```

Other formats require different patterns of data words. Format number 16, for example, is an octal dump format. It requires a first data word containing addresses delimiting the dump, followed by the words to be listed. Note that this pattern of data may be produced by one entry into RWD2. A few formats require no data words at all. Format number 11 causes a page eject, and would be followed directly by some other format number.

Format number 0 has special significance. The line of coding:

```
    ,        ,          RWF1,         L(0),         $
```

will cause the output hopper within the format routine to be dumped on tape whether the hopper is full or not. This line should appear near the end of each program after all output data has been printed or dumped.

It is relatively easy to add new formats to the repertoire of the Output Processor as the need arises. Writeups of the output subroutines and a list of the formats now available follow.

OUTPUT PROCESSOR FORMATS

0	DUMP OUTPUT·HOPPER
1	ONE BLANK LINE
2	TWO BLANK LINES
3	THREE BLANK LINES
10	PAGE NUMBER
11	PAGE EJECT
12	HALF PAGE POSITION
13	THIRD PAGE POSITION
14	QUARTER PAGE POSITION
16	OCTAL DUMP
17	OCTAL OUTPUT
20	TWENTY WORD HEADING
24	FOUR COLUMN HEADING
26	SIX COLUMN HEADING
31	FLOATING BINARY TO FLOATING DECIMAL, ONE COLUMN
32	FLOATING BINARY TO FLOATING DECIMAL, TWO COLUMNS
33	FLOATING BINARY TO FLOATING DECIMAL, THREE COLUMNS
34	FLOATING BINARY TO FLOATING DECIMAL, FOUR COLUMNS
35	FLOATING BINARY TO FLOATING DECIMAL, FIVE COLUMNS
36	FLOATING BINARY TO FLOATING DECIMAL, SIX COLUMNS
38	FLOATING BINARY TO FLOATING DECIMAL, EIGHT COLUMNS
41	STATED BINARY TO STATED DECIMAL, ONE COLUMN
42	STATED BINARY TO STATED DECIMAL, TWO COLUMNS
43	STATED BINARY TO STATED DECIMAL, THREE COLUMNS
44	STATED BINARY TO STATED DECIMAL, FOUR COLUMNS
45	STATED BINARY TO STATED DECIMAL, FIVE COLUMNS
46	STATED BINARY TO STATED DECIMAL, SIX COLUMNS
50	SPECIAL FORMAT FOR RW-300 SIMULATION
56	FLOATING BINARY TO FLOATING DECIMAL WITH IDENTIFICATION INTEGER, SIX COLUMNS
66	FLOATING BINARY TO FLOATING DECIMAL WITH ZERO SUPPRESSION, SIX COLUMNS
76	FLOATING BINARY TO STATED DECIMAL, SIX COLUMNS
86	STATED BINARY TO STATED DECIMAL
96	STATED BINARY TO FLOATING DECIMAL

STANDARD 1103A USE SUBROUTINE

RWF1

OUTPUT FORMAT SELECTOR

PURPOSE: For use with the output processor

SPECS:

SUB ,	RWF1 ,	169
TEMPS ,	0 ,	0
INOUT ,	1 ,	0

INPUT: (1) Any positive integer designating an available format

OUTPUT: Writes on Uniservo No. 3 when 120 word hopper is full or when entered with an argument of zero. Output tape is in form required by output processor.

RESTRICTIONS: This routine must not be destroyed nor restored between successive entries.

CODED BY: D. Wenger (RW) June, 1957

Preliminary Writeup
08-01-57

STANDARD 1103A USE SUBROUTINE

RWP1

PRINT ONE WORD

PURPOSE: For use with the output processor

SPECS:

SUB ,	RWP1 ,	9
TEMPS ,	0 ,	0
INOUT ,	1 ,	0

INPUT: (1) Any machine word

OUTPUT: No direct output. May cause RWF1 to write on Uniservo No. 3. Net effect is to write argument for processing.

SUBSIDIARY ROUTINES: This routine uses the format selector routine RWF1.

CODED BY: D. Wenger (RW) June, 1957

STANDARD 1103A USE SUBROUTINE

RWD1

DUMP SPECIFIED RANGE

PURPOSE:	For use with the output processor
SPECS:	SUB , RWD1 , 76
	TEMPS, , 3 , 0
	INOUT , 1 , 0
INPUT:	(1) A word of the form: 00 uuuuu vvvvv where uuuuu and vvvvv are the addresses of the first and last data words to be dumped.
OUTPUT:	May write on Uniservo No. 3 either directly or via RWF1. Net effect is to write all words from uuuuu through vvvvv for processing.
RESTRICTIONS:	Addresses uuuuu and vvvvv must be either both in cores or both on drum.
SUBSIDIARY ROUTINES:	This routine uses routine RWF1.
CODED BY:	D. Wenger (RW) June, 1957

STANDARD 1103A USE SUBROUTINE

RWD2

DUMP SPECIFIED RANGE WITH ADDRESSES

PURPOSE: For use with the output processor

SPECS:

SUB	RWD2	13
TEMPS	0	0
INOUT	1	0

INPUT: A word of the form:

00 uuuuu vvvvv

where uuuuu and vvvvv are the addresses of the first and last data words to be dumped.

OUTPUT: May write on Uniservo No, 3 either directly or via RWF1. Net effect is to write the argument and all words from uuuuu through vvvvv for processing.

RESTRICTIONS: Addresses uuuuu and vvvvv must be either both in cores or both on drum.

SUBSIDIARY ROUTINES: This routine uses routines RWF1, RWP1, and RWD1.

CODED BY: D. Wenger (RW) June, 1957

STANDARD 1103A USE SUBROUTINE

RWD3

DUMP SPECIFIED RANGE AND CLEAR

PURPOSE: For use with the output processor

SPECS:

```
SUB   , RWD3 , 2 ⊗
TEMPS , 0    , 0
INOUT , 1    , 0
```

INPUT: (1) A word of the form:

OO uuuuu vvvvv

where uuuuu and vvvvv are the addresses of the first and last data words to dumped.

OUTPUT: May write on Uniservo No. 3 either directly or via RWF1. Net effect is to write all words from uuuuu through vvvvv for processing and to clear cells uuuuu through vvvvv.

RESTRICTIONS: Addresses uuuuu and vvvvv must be either both in cores or both on drum.

SUBSIDIARY ROUTINES: This routine uses routine RWF1, and RWD1.

CODED BY: D. Wenger (RW) June, 1957

APPENDIX C

STANDARD WRITEUP FORM

FOR USE ROUTINES

November 22, 1957

Note: In the following outline all headings and sub-headings which are underlined must appear in a USE routine writeup -- if in any particular writeup such a heading is not applicable, either the phrase "not applicable" or "none" must follow that heading.

In upper right corner of each page: routine tag with the date under it. If applicable, the word "Corrected" will precede the date on the first page and on all other corrected pages.

In top center: First line, Title. Second line, Compilable/Non-Compilable, Minimum 1103A/Non-Minimum 1103A. Third line, Organization and author.

Correction information: If applicable, the phrase "Correction Information:" followed by an adequate description of the nature and effect of the correction, must appear next in the writeup. If this information is extensive, it may be merely referenced at this point and explained in sufficient detail at the end of the writeup (see Heading F).

A. PURPOSE:

Concise statement of what routine does. Notation may be introduced at this point if convenient or appropriate.

B. USAGE: Standard/Non-Standard

1. Entrance. If the entrance is standard, the sub-heading "Entrance" should not appear. If the entrance is non-standard, the sub-heading "Entrance" must appear followed by a detailed description of the entrance procedure.

2. Exit. Same as above for "Entrance."

3. LEADING LINES. The (three) "Leading Lines" of a subroutine shall be reproduced here. If Leading Lines do not actually appear as part of the coding of the routine, the information normally contained therein must be supplied using the same format. A fourth line specifying the number of unmodified constants, must be included here.

4. INPUT. All necessary information about the input to the routine should be included, such as range, scaling, detailed composition of parameter words, etc. In case the routine requires multiple inputs (i.e., the u-address part of the INOUT line is greater than one), the sequence of these inputs must be clearly indicated.

5. OUTPUT. All necessary information about the output of the routine should be included, such as, accuracy, scaling, detailed description of format, etc. In case the routine produces multiple outputs (i.e., the v-address part of the INOUT line is greater than one), the sequence of these outputs must be clearly indicated.

6. ERROR EXIT and/or RECOVERY PROCEDURE.

7. NUMBER of TAGS USED.

8. RUNNING TIME. Maximum time must always be stated. Average and minimum may be stated. If average time is given, the method of computing this time must be described.

C. RESTRICTIONS:

Conditions which must be satisfied for the correct operation of the routine. Examples are:

1. Components required other than the minimum 1103A.

2. Restrictions on data (range, quantity, format, etc.).

3. Parameter ranges.

4. Timing conditions which must be met for the external equipment to run without fault, drum references, etc.

5. Conditions under which use of the routine may be undesirable.

D. ADDITIONAL PROGRAMMING AND OPERATING INFORMATION:

This section covers in detail all additional information needed to use the routine. Examples are:

1. Other programs required.

2. Special storage used such as F1 or F2, or intermediate tapes.

3. Control data.

4. Locations and octal equivalents of key constants.

5. Detailed effects of using the routine, such as results of special conditions.

D. ADDITIONAL PROGRAMMING AND OPERATING INFORMATION - continued:

6. 1103A operating instructions, for example, tape positioning, tape changes, card cycling, switch settings, etc.

7. Equipment and setups needed to list output, card processing, wiring diagrams, etc.

E. METHOD:

A short description of the fundamental logic used in constructing the routine and the conditions under which it is most effective. In case of mathematical routines the derivation or reference should be included. A flow chart may contribute greatly to the understanding of the method.

F. Correction Information:

To be used only if not completely described following the Title section.

G. Coding:

Coding should be included with all routine writeups submitted to the USE organization and shall contain sufficient comments to aid effectively in following the logic and mathematics of the routine.

Approved by USE Policy Committee
November 22, 1957

December 4, 1957

APPENDIX D

CONVENTIONS FOR USE ROUTINES

Requirements and restrictions on USE routines arise from two sources. The USE Compiler requires that certain procedures be followed in order that a routine be a compilable subroutine. Other conventions have been adopted by USE in the interests of standardization. These should be followed wherever it is reasonable to do so, and where they are not followed this fact should be made clear in the writeup.

Conventions for a Compilable Subroutine

Compilable subroutines are written in the same form as other coding for the USE Compiler with certain exceptions which are described here.

The item number field should be left blank on all lines of coding of a subroutine.

A subroutine consists, in general, of eight parts:

1. Leading lines
2. Entrance line
3. Alarm exit line
4. Normal exit line
5. Result cells
6. Argument cells
7. Body of the routine
8. Ending line

1. The first line of a subroutine must have the special control symbol "SUB" in the operation code field to indicate that a subroutine is to be processed. The u address field contains the name of the subroutine. If the subroutine is in the internal machine library its name may consist of any combination of from one to six alphanumeric characters which is not the same as any other operation code symbol. If the subroutine is an external one supplied along with the main program its name must consist of one of the organization letter pairs listed in Table I followed by from one to four alphanumeric characters.

   The v address field of a "SUB" control line contains an integer which is equal to the number of consecutive cells required by the subroutine. This includes cells for the entrance, alarm exit, normal exit, results, and arguments, and for instructions, constants, and subsidiary subroutine calling sequences in the body of the routine, but does not include cells used in the subroutine temporary pool.

Following the first line normally there are two lines introduced by the special control symbols "TEMPS" and "INOUT," in the operation code field.

A "TEMPS" control line is used to indicate to the compiler what part of the subroutine temporary pool in the compiled region is to be used by the subroutine. The u address field contains an integer which is equal to the number of cells to be left at the beginning of the temporary pool ahead of those used by this subroutine. These may be temporaries used by subsidiary subroutines. If either address field is blank, the corresponding quantities are taken to be zero.

An "INOUT" control line is used to specify the number of arguments and the number of results. The u address field contains an integer which is equal to the number of parameters and/or arguments which must be placed within the subroutine before it is entered. The v address field contains an integer which is equal to the number of results which the subroutine computes and stores within itself. If either address field is blank, the corresponding quantities are taken to be zero.

2. The entrance line produces the first word of the machine language subroutine. It should be an unconditional jump to the body of the subroutine.

3. The alarm exit line should have the control symbol "ALARM" in the operation code field. This produces the second word of the machine language subroutine. The compiler will supply an appropriate instruction for the cell. This will depend on the computation system in use at a particular installation and might, for example, be a return jump to an alarm printout routine located at a fixed position on the drum

4. The normal exit line produces the third word in the machine language subroutine. It should be an unconditional jump instruction which may be set up by a return jump instruction in the main program.

5. Result cells and

6. Argument cells may be reserved within the subroutine immediately following the normal exit either by use of the "RESERV" control line or by making entries in the tag field on the correct number of lines.

7. The body of the subroutine may contain the following types of lines:

    Lines which produce 1103A instructions
    Lines which produce numbers
    Lines which produce subroutine calling sequences
    "EQUALS" and "RESERV" control lines

These lines may be written just as in other (non-subroutine) coding for the compiler except that:

a. No item numbers may be used in the u or v fields.
b. No constant pool addresses of the form "L(...)" may be used.
c. Tags which appear in the v address field of lines which produce subroutine calling sequences should not appear in the tag field. They are equated by the compiler to the machine locations associated with the first word of the subsidiary subroutine thus called for.
d. Other tags which appear in the u or v address fields but not in the tag field are equated, in the order of their occurrence, to the addresses of cells in the subroutine temporary pool in the compiled region.

8. The ending line of a subroutine must contain the special control symbol "ENDSUB" in the operation code field. The contents of the address fieldsare insignificant.

Conventions To Be Followed Where Reasonable

1. Use the language of the USE Compiler.

2. Use only the minimum 1103A (See Table II).

3. The name should have exactly six characters the first two of which are the organization letter pair.

4. Write a compilable subroutine.

5. Previous to the time of entrance to a subroutine the arguments and/or parameters should have been transferred to specific cells within the subroutine. (Namely, the cells immediately following the cells reserved for results.)

6. At the time of normal exit from a subroutine the results should be stored within the subroutine in the fourth and following cells. (They may, in addition to this, be stored in the accumulator, the Q register, or elsewhere.)

7. At the time of alarm exit, leave the name of the subroutine, in flexowriter code in the Q register.

8. The body of the routine should be in this order:

   Instructions
   Constants
   Working Storage (in addition to temporary pool, if any)

9. Coding submitted with USE subroutines should include constants, each in decimal equivalent to the original formulation value times the appropriate scaling factors.

10. Interpretive routines may be written as subroutines with no arguments nor results where a standard entry sets up an appropriate jump in cell F2.

11. Double Precision Floating Numbers

    A standard double precision floating point number shall occupy two consecutive storage cells. The first cell shall contain a sign bit, an eight bit biased characteristic, and the 27 most significant bits of the mantissa; the second cell shall contain the 36 least significant bits of the mantissa.

12. Complex Numbers

    Complex numbers shall occupy consecutive storage cells, the real part preceding the imaginary part.

TABLE I

The following is a list of the organization letter pairs currently recognized by the USE Compiler. These are the only permissible leading characters for external subroutine names:

AP	Applied Physics Lab., Johns Hopkins University
BA	Boeing Airplane Company
CE	U. S. Army, Corps of Engineers
HO	Holloman Air Force Base
ML	Missiles Systems Division, Lockheed Aircraft Corp.
RR	Remington Rand Division, Sperry Rand Corporation
RW	The Ramo-Wooldridge Corporation
WF	Wright Air Development Center

A simple change in the compiler will substitute other letter pairs for these.

TABLE II

Minimum 1103A

Basic 1103A with 4096 words of core storage and Flexowriter output

Controlled reproducer for punched cards

Ferranti paper tape reader

Teletype paper tape punch

5 uniservo magnetic tape units

Off line high-speed printer (plotting modification)

APPENDIX E

Suggested Covering Letter

for

USE Work in Progress Reports

At the November, 1957, USE meeting the Policy Committee directed that a method be set up for regular reporting by each installation on their Work in Progress. The purpose of the Report is to inform all members about all unclassified projects which are under way at all installations no matter what the status may be. It seems clear that such reports will promote effective exchange of information among persons working on similar projects and in many cases will prevent duplication of effort.

In order for the reporting system to be effective, it must be simple and require a minimum of effort on the part of each installation. The attached form and the numbering system is designed to achieve those goals. Suggestions for filling out the form are given here and ought to be followed whenever practicable.

1. Report Number. Each complete report compiled and submitted by a member organization should be assigned a serial number, starting with 1 for the first report, 2 for the second, etc.

2. Report Compiled By. The name entered here should be that of a single person in the organization who has coordinated the gathering of the information.

3. Reference Number. The reference number consists of two numbers seperated by a dash. The first is the number of the Work in Progress Report in which the project was first described. The second is the serial number within that report.

4. Tag. If the project has reached the stage where a USE routine is being produced and a tag has been assigned, that tag should be filled in here. The presence of this column should not be construed to mean that a project should not be reported unless a USE routine will result -- as a matter of fact, the greatest value of this report will be in reporting progress on all projects, from their earliest stages, whether or not they may ever result in a computer program.

5. Concise Description. Include here a short abstract or a one or two sentence description outlining the purpose, method, special advantages, etc., of the project. Include enough so that an interested person at another installation will know whether he should follow up with an inquiry for more information. The name of the person or persons actually working on the project should be included -- this will expedite correspondence concerning the project.

6. Coding Language. If a computer code exists, give the name of the coding language, for example, FAP, RECO, USE, etc.

7. Status Codes. One or more Status Code numbers as described on the form should be specified here. Code 12, "Would like to have," is perhaps always implied by many of the other codes. However, it may be specified without other codes to indicate an active interest in or a foreseeable demand for a particular study, program or mathematical method.

In order for this report to be of real value, the status of all projects reported should continue to be given in each subsequent report until the status code either implies completion (4,5,6, or 9) or shows that the project has been dropped. It is hoped that a project shown as deferred will continue to be reported until its status changes.

The primary purpose of the permanent Reference Number is to allow continued reporting of a project without repeating the full abstract or description in each subsequent report. If this scheme is used, although the first report may require considerable effort, subsequent reports should be much easier. It may be helpful to describe all new projects first in each report and then complete the report by giving the status of all previously reported projects in reference number sequence.

The mechanics of distributing the reports may be of interest. About six weeks before each USE meeting, the Executive Secretary will send to each member organization an ample number of copies of the Work in Progress Report. The Report should be compiled and returned to the Executive Secretary within ten days. After reproduction of all reports received the Executive Secretary will distribute copies to all USE members in the regular manner. If the schedule is adhered to, these copies should be in the members hands about ten days or two weeks before the USE meeting, thus allowing time to study the reports and to plan any action that might be taken as a result.

It appears certain that this new series of Work in Progress Reports will be of benefit to all members and to the USE Organization as a whole. Their value over a period of time should far outweigh the effort which each member puts into his report. If a little extra effort and time is given to the first set of reports, an excellent basis will have been established, and the relative ease with which subsequent reports can be prepared will assure continued success of the system -- success which will be measured in terms of increasing benefits to all members.

UNIVAC SCIENTIFIC EXCHANGE

WORK IN PROGRESS

REPORT NO.____

Page ___ of ___

Date____________

Submitted by________________________________ (Member Organization)

Report Compiled by____________________

Reference Number*	Tag, if Assigned	Concise Description of Purpose, Method, Special Advantages, etc. Include name of cognizant person	Coding Language	Status** Code(s)

* Consists of two parts: Number of report containing first reference, dash, serial number in that report. Serial numbers are assigned to all new material, starting with number 1 in each report.

** 1, Under consideration. 2, In analysis and/or specifications stage. 3, Coding and check-out underway. 4, Checkout completed. 5, Preliminary writeup or report available. 6, Forma writeup or report available. 7, USE distribution planned. 8, USE distribution not planne 9, Has been distributed. 10, Project deferred. 11, Project dropped. 12, Would like to hav

APPENDIX F

One of the important activities of the Product Planning Department of Remington Rand Univac is to evaluate and analyze new developments, both applicationwise and componentwise, and apply these studies toward future computer designs. To obtain data needed for developing improved logic and systems, we wish to request the aid of the Users. The aid needed is in the vast field of applications toward which your computer is being used.

Specifically, what is needed is the bread and butter applications which are daily being applied to your installation. These would, of course, be non-classified applications in accordance with government and/or company regulations. The form of these applications should be detailed problem statements containing the following:

1. Statement of the application and its purpose.
2. The method used for establishing solutions (e.g., equations of the problem and numerical methods applied, algorithms used).
3. Amount of computation required (e.g., accuracy needed).
4. Types and forms of in-out.
5. Duty rates of in-out (e.g., for temporary storage, final output, segmentation, etc.).
6. Percentage of computer time used for the particular problem or class of problems. (Percent weekly, monthly, yearly, per one-hundred computer hours, etc.)
7. Possible future applications.

Programs in the language of a particular computer are <u>not</u> desired. Actually what is basically needed is the analyst's description down to the point where he gives his problem to a programmer for machine coding.

There perhaps exists several applications analyzed, but found not economically feasible to run on present type computers due to the limitations of the computer itself. Data of these type are particularly desired.

It is realized that perhaps many of the results of past analysis are in a single file copy or handwritten form. In these cases individual arrangements will be necessary.

Remington Rand would like to accomplish this task at a minimum interference to the installation concerned. Any comments, criticism, or suggestions you may wish to include to accompany these data will be welcomed and appreciated.

USE COMMITTEE REPORT
November 21 & 22, 1957
INSTALLATIONS OPERATIONS COMMITTEE

The Installations Operations Committee met during the period Thursday, 21 November thru Friday, 22 November 1957 to consider the following agenda items:

1. A switch to bypass the typewriter.
2. The status of the new maintenance routines.
3. Attachment of peripheral equipment.
4. Machine logging procedures and time reporting to USE.
5. The policy on fault circuitry.
6. Variable block operation of UNISERVOS.
7. Allocation and permanency of Dead Space storage.
8. A program and real time clock for program reference.

The following member representatives were present at all or part of these meetings:

G. Clark (OR) (Chairman)
R. Rich (AP)
W. Wooton (ML)
R. Perkins (RW)
M. Green (HO)
B. Horton (CE)
R. Petonke (CE)
R. Schmidt (RR)
L. Wick (RR)
L. Dominic (RR)
L. Graham (WS)
D. Zonars (WF)
D. Hiser (BC)

Boeing Aircraft was not represented. In addition to those listed above, representatives from various non-voting member organizations were in attendance.

1. A switch to bypass the typewriter

Spencer (CE) proposed this item in the interest of (a) speeding up production work by means of eliminating previously programmed type-outs or (b) eliminating the need for putting the 1103A on maintenance in the event that the typewriter is out of order. Considerable interest was expressed by other member organizations in discussion of this proposal. As a result, the following action was recommended to the Policy Committee:

> "It is requested that RR consider the engineering work necessary to install a typewriter bypass switch and prepare a cost estimate for USE by the next meeting, provided that such action does not delay modifications which are now in process."

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2. The status of the new maintenance routines

Dominic (RR) reported that at present RR has four (4) people engaged in this effort. Three (3) broad categories of maintenance routines are planned and are, at present, in various stages of development. The categories are:

(1) Acceptance Tests
(2) Confidence Tests
(3) Diagnostic Tests

Immediate past emphasis of this group has been devoted to the development of Diagnostic Routines for the UNISERVOS. These routines have been completed and are now being circulated to the installations. The UNISERVO tests include three (3) test types which are listed as follows:

a. Tests for all possible operations and modes
b. Durability or life tests
c. Timing tests

The group in St. Paul is interested in receiving any suggestions or routines which equipment users have developed. The target date for completion of the 1st revision of the Diagnostic Routine maintenance package is by the next USE meeting.

The view was expressed by several organizations that where possible maintenance routines should operate with a drum interlace of 4 since this is the most frequently used. Accordingly, the following resolution was proposed by Rich (AP):

"The Policy Committee is requested to urge RR to design all maintenance routines to operate with a 4-interlace; particularly those routines to be contained in the packages for Confidence Testing and Diagnostic Testing."

3. Attachment of peripheral equipment

A listing of standard and non-standard equipment; in operation, being installed, under design, or being planned for each installation prepared by the chairman IOC is attached as Appendix A of this report. This list will be submitted to Bob Schmidt (RR) for up-dating and additions prior to distribution through normal USE channels.

4. Machine logging procedures and time reporting to USE

Discussion of this item disclosed that several member organizations do not, at present, keep their machine records in a way that enables determination of the efficiency figures agreed upon during the previous USE meeting. In addition, it was pointed out that various members may wish to derive different ratios from those previously described. It was suggested that RR presently collects the records needed to obtain the efficiency ratios from all the rental installations and if these figures could be obtained for the owned installations, discussion and comparison of these figures at each USE meeting

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might be more in order. Accordingly, the following resolution was made:

"RR is requested to obtain from all installations and to furnish to the IOC at each USE meeting, the following times:

(a) Preventative maintenance
(b) Scheduled time
(c) Emergency maintenance
(d) Calendar period for the report
(e) Actual operating time

Further, all installations shall report total lost time in hours on an individual basis. (Lost time is defined as that time for which the customer pays which, due to equipment malfunction, does not produce useful results."

(Discussion of the above resolution in the Policy Committee resulted in deferring consideration on this item until the next USE meeting.)

The efficiencies previously agreed upon were reported as average during the past three months of operation:

*RW - Customer efficiency - 93%
Installation efficiency - 63%

*ML - C = 89.09%
D = 85.78%
E = 54.94%

AP - C = 97%
D = 100%
E = 59%

CE - C = 89%
D = 72%
E = 60%

HO - No report

BA - No report

OR - A = 92%
B = 51%
C = 96%
D = 91%
E = 51%

* Submitted report attached

5. The Policy on fault circuitry

In discussion of this item it was pointed out that several installations were of the impression that the IOA fault circuits on the 1103A should be rendered inactive by removal of a tube in order that the Ferranti Reader could perform correctly. Hence, a statement of policy was requested from RR. Dominic (RR) reported that company policy requires that all fault circuits be active. It was recognized, however, that with the IOA fault circuit active the Ferranti Reader may produce incorrect fault indications. Hence, the following was submitted to the Policy Committee for action:

> "It is requested that RR investigate the conditions which cause fault indications from the Ferranti during normal operations and report at the next USE meeting what, if any, remedial action can or has been taken."

6. Variable block operation of UNISERVOS

Discussion of this item brought out the fact that a modification of the UNISERVO is presently in progress that will make possible interchanging the mode of operation from fixed to variable on the writing and reading of tapes (i.e., a tape written in fixed format may be read in variable). This modification has not yet been made on all 1103A's. No action was taken by the IOC on this item.

7. Allocation and permanency of Dead Space storage

Discussion of the allocation of Abnormal Drum storage revealed that some installations (BA and CE) allow full use of the available Dead Space for programmers. However, most installations share the Dead Space between maintenance and programmers on the basis of 25/75, 50/50 or 75/25. There appeared to be no uniformity of division. In addition, it was pointed out that where maintenance does use a portion of the Dead Space in general, the maintenance routines are stored in a 16-interlace. As noted previously in the discussion of item 2, it would be desirable in the future if maintenance routines could be designed to work with a 4-interlace. No action was taken by the IOC on this item.

8. A Program and Real Time Clock

Both ML and RW proposed the design of a clock which could be referenced program wise by the 1103A. Other installations also expressed an interest in this feature. After some discussion, the general design features of such a clock were set down as follows:

1. The clock should be capable of counting either real time or program steps. When counting real time the clock should count time in increments of not less than 30 seconds for a period not greater than 24 hours. In counting program steps the clock should be capable of counting each instruction in a program for a maximum of 1,000 steps.

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2. There should be a means of manually presetting the clock so that operations can be halted (interrupted) at a preselected time or program step.

3. It should be possible to read the contents of the clock from a program by means of an EF followed by an ER.

It was requested that RR consider the design of this device and perform a cost estimate by the next USE meeting.

Respectfully submitted,

George E. Clark Jr.

George E. Clark
(IOC, Acting Chairman)

3 Enclosures

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APPENDIX A

1103A with:	Additional Equip:	On Order:	Under Consideration:
AP (Do not use USE COMPILER) 2 banks of MC HSP on-line (with plotter) Floating Pt. Arith. 5 Uniservos, fixed blk. Bull, PTP, PTR, Flex. Tape Prep. II	Unityper II IBM 650 407 Tab. Sorter Collator Reproducer	Alpha. attachment for 650	Analog-Dig. Conv. - on and off line
CE (Use USE COMPILER) 2 banks of MC HSP off-line w/o plotter (with burster and separator) Fixed Pt. Arith. 9 Uniservos, variable blk. Bull, PTP, PTR, Flex. Tape Prep. II	2 Unityper II IBM Key Punch Collator Reproducer		MT testing equipment 3rd bank of MC MT buffer system Double Drum Ultra-high speed printer Anything to anything converter
WS (Use USE COMPILER) 2 banks of MC Floating Pt. Arith. 5 Uniservos, variable blk. Bull, PTP, PTR, Flex. Tape Prep II	BRL designed Potter Tape handler Doppler Data Translator Card to Tape Conv. Tape to Card Conv. 407 Tab. Printing Key Punch IBM 604 Sorter Reproducer Summary Punch 2 Veriplotters IBM PT to PC Conv.		

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1103A with:	Additional Equip:	On Order:	Under Consideration:
<u>HO</u> (Do not use USE COMPILER) 1 bank of MC Fixed Pt. Arith. 9 Uniservos, variable blk. Bull, PTP, PTR, Flex. Tape Prep. II	2 Unityper II IBM Key Punch 407 Tab.	2nd 1103A with: 1 bank of MC Fixed Pt. Arith. 5 Uniservos, variable blk. Bull, PTP, PTR, Flex.	Data Assimilater Central Computer Exchange to transmit Info between 1103A's Range data input and output equip.
<u>ML</u> (Do not use USE COMPILER) 1 bank of MC HSP off-line w/o plotting Fixed Pt. Arith. 10 Uniservos, fixed blk. Bull, PTP, PTR, Flex. Tape Prep. II	Modified Veriplotter with summary punch 407 Tab. Sorter 2 Reproducers Collator Interpreter 4 Key Punches 4 IBM 650 3 Unityper II	2nd (Mar. 1958) 1103A with: 2 banks of MC Floating Pt. Arith. 10 Uniservos, variable blk. (buffers when available) Bull, PTP, PTR, Flex. (1st 1103A brought up to 2nd mach. std.) Card to Tape Conv. Tape to Card Conv. Tape Verifier Tape Plotter (off-line) Analog to Dig. Conv.	Program Clock (real time)

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APPENDIX Aii

1103A with:	Additional Equip:	On Order:	Under Consideration:
<u>WF</u> <u>On order</u>: 3 banks of MC HSP on-line, w/o plotter Floating Pt. Arith. 4 Uniservos, variable blk. Bull, PTP, PTR, Flex. Tape Prep. II	407 Tab. Sorter Key Punch on-line stylus printer	(con'd): Unityper II Verifier	
<u>BA</u> (Use USE COMPILER) 1 bank of MC HSP off-line, plotter 6 Uniservos, variable blk. Bull, PTP, PTR, Flex. 2 Special MT handlers Analog to Dig. Conv.	2 Unityper II Card to Tape Converter		
<u>RW</u> (Use USE COMPILER) 1 bank MC HSP off-line with plotter Floating Pt. Arith. Bull, PTP, PTR, Flex. 7 Uniservos, variable block Tape Prep. II	IBM 407 Sorter Collator 4 Unityper II Card Key Punch EPSCO Adaverter Verifier		
<u>BC</u> (Use USE COMPILER) <u>2 X 1103B with</u>: 2 bank MC each 10 Uniservos per system (variable blk, backward buffer) Fixed Pt. Arith. PTP, PTR, Flex. (No Bull)	FOSDICK Film to Tape Conv. Shepard HSP		Plan to rent 2 X 1103B (additional) during 1959-1960 for Census Assignment of Servos between 1103A's and peripheral equip.

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1103A with:	Additional Equip:	On Order	Under Consideration:
OR (Use USE COMPILER)			
1 bank MC	Unityper II	Remote Flex	
	407 Tab.	input-output	
Fixed Pt. Arith.	Sorter	Charactron HSP	
5 Uniservos, variable blk.	Collator		
Bull, PTP, PTR, Flex.	Reproducer		
Tape Prep II	Interpreter		
	2 Key Punches		

Enclosure #1

1103A Time Records at The Ramo-Wooldridge Corporation

November 15, 1957

The Digital Computing Center of the Ramo-Wooldridge Corporation does not use a Daily Log Sheet, per se, in recording runs on the 1103A computer; instead, a log card is filled out for each computer run. Any anomalies which may arise during that run are recorded with an appropriate explanation on the log card. An example of this log card is attached. The log cards for a 24-hour period are then keypunched and a Daily Usage Report is made. The Daily Usage Reports, in turn, are used to formulate a Weekly 1103A Usage Report. Both the Daily and Weekly Usage Reports have the same format. A sample of the latter report appears in Appendix A.

The Weekly 1103A Usage Reports were used to compute the Customer Efficiency and the Installation Efficiency for the fifteen-week period beginning 29 July 1957 and terminating 10 November 1957. A graph reflecting this information can be found in Appendix B.

The necessary terms used to derive these Efficiency percentages were defined from the Weekly Usage Report as follows:

Definition		From the Weekly Report
Available Time	=	Good Time + Lost Time
Productive Time	=	Good Time + the following Lost Time: Idle, Power Failure, and Other*
Total Time	=	Good Time + Lost Time + Down Time + Preventive Maintenance

* Other refers to operator error, keypunch error or to any other lost time not due directly to the computer.

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APPENDIX A

Weekly 1103A Usage Breakdown

From 0800 11-04-57

to 0800 11-11-57

		Total Time	Per Centage
Good Time	Assembly	11.26	9.7
	Code Check	28.17	24.2
	Production	59.13	50.9
	Demonstration		
	Total	98.56	84.8
Lost Time	Idle		
	Machine Error	3.55	
	Power Failure		
	Peri. Equipment	1.98	
	Magnetic Tape	2.20	
	Other	2.00	
	Total	9.73	8.4
Down Time	Magnetic Core		
	Magnetic Drum	.54	
	H.S. Punch		
	Bull	1.51	
	Magnetic Tape	.16	
	Ferranti	.10	
	Test	1.14	
	PWR Supply		
	Other	4.45	
	Total	7.90	6.8
Preventive Maintenance		23.66	
	Total	23.66	
Off the Air		28.15	
	Total	28.15	

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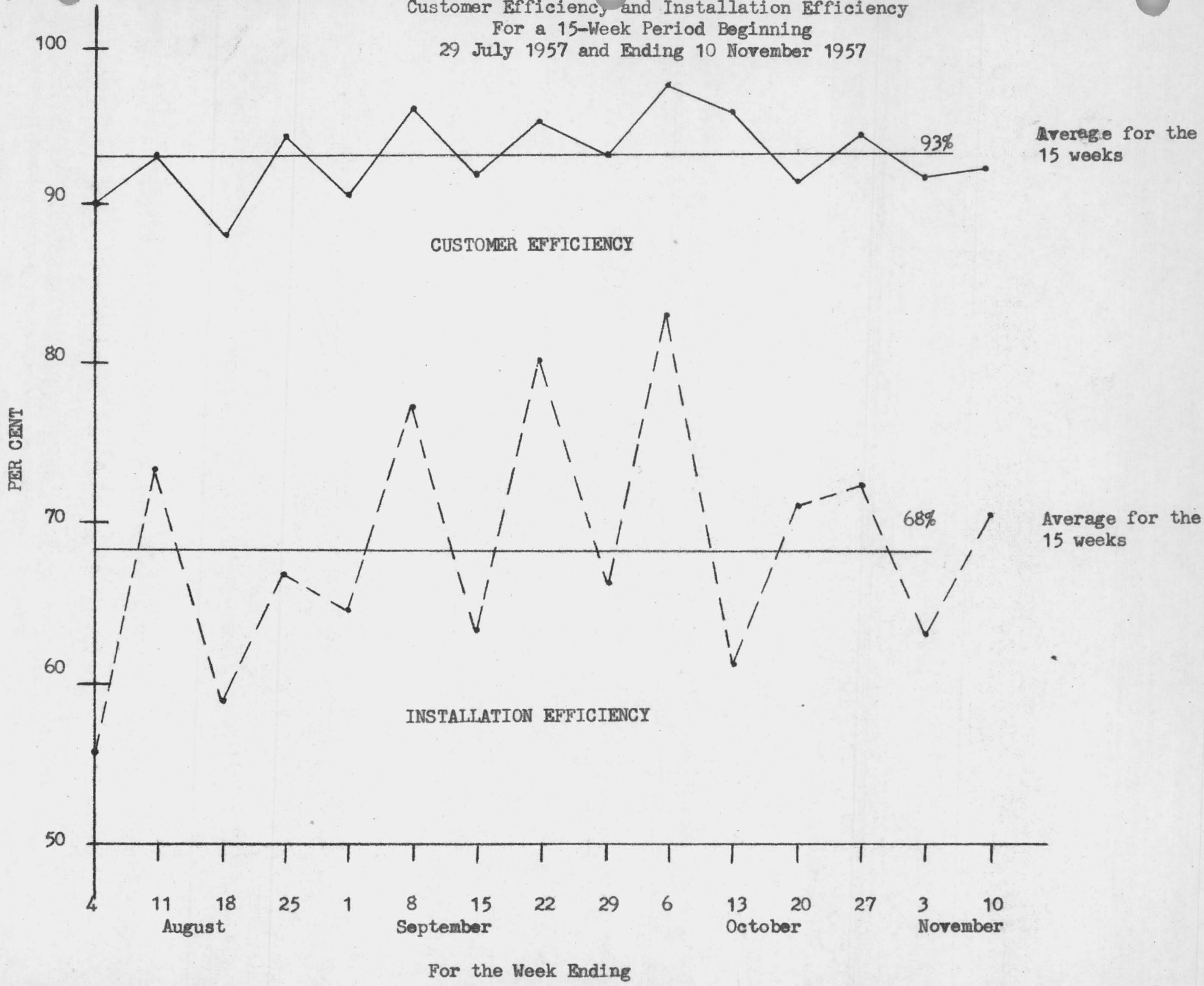
APPENDIX B

Customer Efficiency and Installation Efficiency
For a 15-Week Period Beginning
29 July 1957 and Ending 10 November 1957



Enclosure #2

LOCKHEED AIRCRAFT CORPORATION
Missile Systems Division
Sunnyvale, California

REPORT TO USE OPERATIONS COMMITTEE:

The following ratios are taken from LMSD 1103A machine time records covering the period August 1, 1957 to October 31, 1957.

$$C = \frac{A - L}{A} = 89.09\%$$

$$D = \frac{A - L}{S} = 85.78\%$$

$$E = \frac{A - L}{S\&P} = 54.94\%$$

A = Available time = scheduled time - Emergency maintenance.

L = Lost time for all reasons.

S = Scheduled time.

P = Preventive maintenance.

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USE Letter No: PC-5 December 11, 1957

To: USE Policy Committee, Publications Committee, Installation Heads.

Subject: Reproduction Methods of USE Material.

In accordance with the wishes of the Policy Committee, Remington Rand Sales has investigated the various reproduction methods available to them for producing USE material. It would appear that the Plastiplate Offset method would be most advantageous to all: this would entail the preparation of USE material on Plastiplates which would be forwarded to myself for immediate printing. A vellum could be run during the printing for filing and for future ozalid copies if required.

However, we would like to temporarily defer using this procedure. The Scientific Sales Department of Remington Rand is scheduled to move from St. Paul, Minnesota to New York City. Until this move is completed, we would prefer to retain the present vellum master procedure. Once established in New York, we can update our procedures accordingly.

Dirk de Vries

Dirk de Vries
Executive Secretary, USE
Remington Rand Univac,
Univac Park,
St. Paul 16,
MINNESOTA.

DdV:diw

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December 2, 1957

To Members of USE:

As agreed at the recent USE meeting, The Ramo-Wooldridge Corporation is undertaking a modification of the USE Compiler to permit the inclusion of excess-three coded constants in a USE program. The proposed specifications for the modification are attached.

We would appreciate comments as soon as possible from those installations interested in this feature as to whether the proposed specifications are satisfactory and, if not, suggestions for improvement.

Sincerely,

Robert Perkins

Robert Perkins
Member of the Technical Staff
Digital Computing Center
The Ramo-Wooldridge Corporation

RP:jm
Attachment

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December 2, 1957

Proposed Specifications for Modification to USE Compiler

The USE Compiler will be modified to recognize a new operation introduced by

XS3 or XS3 - n   (n = 1, 2, ...9)

in the operation code field, XS3 is equivalent to XS3 - 1. Each such line of coding will produce n words of six excess-three characters in the machine language program.

Normally the desired characters are simply written in the u and v address fields. However, the space is represented by an asterisk, and certain other special characters are represented by a character pair. The first character of such a pair is always # (35 octal). The complete list of characters is given below.

As in the case of numbers the characters may be written right across both the u and v fields. The comma which separates the u and v fields may appear before, among, or after the desired excess-three characters and will be ignored. If an excess-three comma is desired the character pair shown below must be used. If the number of characters produced by the contents of the u and v fields is less than 6n the n words will be filled out with space characters (01 octal). If greater than 6n only the first 6n characters will be used, and a warning will be given. Since a DUPO instruction may preceed an XS3 - n instruction it will be reasonably convenient to introduce several words of excess-three information.

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XS3 Character Desired	Write
Digits 0 thru 9	Digits 0 thru 9
Letters A thru Z except O	Letters A thru Z except O
., -, +,), (, /	., -, +,), (, /
Space	*
Letter O	#O
Fast Feed 1	#1
" " 2	#2
" " 3	#3
" " 4	#4
Asterisk *	#A
Breakpoint β	#B
Comma ,	#C
Dollar sign $	#D
Multiline	#M
Number sign #	#N
Stop code	#S

Talmadge

Report of the Western Committee on
an International Machine Language

January 8, 1958

1. The committee met at Ramo-Wooldridge, Los Angeles, on the 7th and 8th of January, 1958, with the following people present:

   R. Tantzen, HO (Chairman)

   R. Talmadge, ML

   R. Perkins, RW

   D. Combelic, RW

2. Since none of the committee members were quite sure how th European Conference would interpret the phrase "universal language", some time was devoted to a discussion of the possible approaches which might be taken. It was felt that the most likely of these would be:

   A. Set up universal rules for writing flow charts.

   B. Accept an already existing computer language, at the level of FORTRAN, IT, UNICODE, etc.

   C. Define a new language, at a more sophisticated level than anything now in existence.

   The adoption of existing languages, such as mathematics and the natural languages was considered unlikely, since they have not in the past proved to be handly tools with which to properly describe a program.

3. If an approach similar to A. is adopted this committee recommends that the USE Organization adopt a resolution encouraging it's members to support this effort. It appears that no other action would be necessary or desirable at this time.

4. If an existing language is chosen, i.e. if method B. is adopted, this committee's recommendations are as follows:

   A. If the language is FORTRAN, we recommend that USE sponsor a joint effort to code a program which will translate it for the 1103A.

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   B. If the language is any other, we recommend that USE wait for the reaction of the 704 community before making a final decision. An exception occurs for the IT language, since RW is already coding a version of this one for the 1103A.

This committee estimates that the effort required to implement a language, at this level of complexity, whose detailed specifications are fixed, would be about 2 to 4 man years of coding and would best be done by a group of two or three people. The machine time required is estimated at 75 to 100 hours.

In view of these consideration and the widespread use of FORTRAN in the 704 community, this committee feels that USE might well give serious consideration to coding FORTRAN for the 1103A regardless of the outcome of the international conference.

5. If the European Conference decides upon approach C., it is clear that such a long-range program would require the establishment of some working group. In this case we recommend that USE establish a committee to co-operate with this working group, by offering suggestions, criticisms and such other help as may be appropriate.

6. Finally, as the European Conference will be held before the next USE Meeting, we recommend that someone report on the outcome of this Conference at the next USE Meeting.

Respectfully submitted,

ROBERT G. TANTZEN, Chairman