8110 K : A COMPOSITION PROJECT

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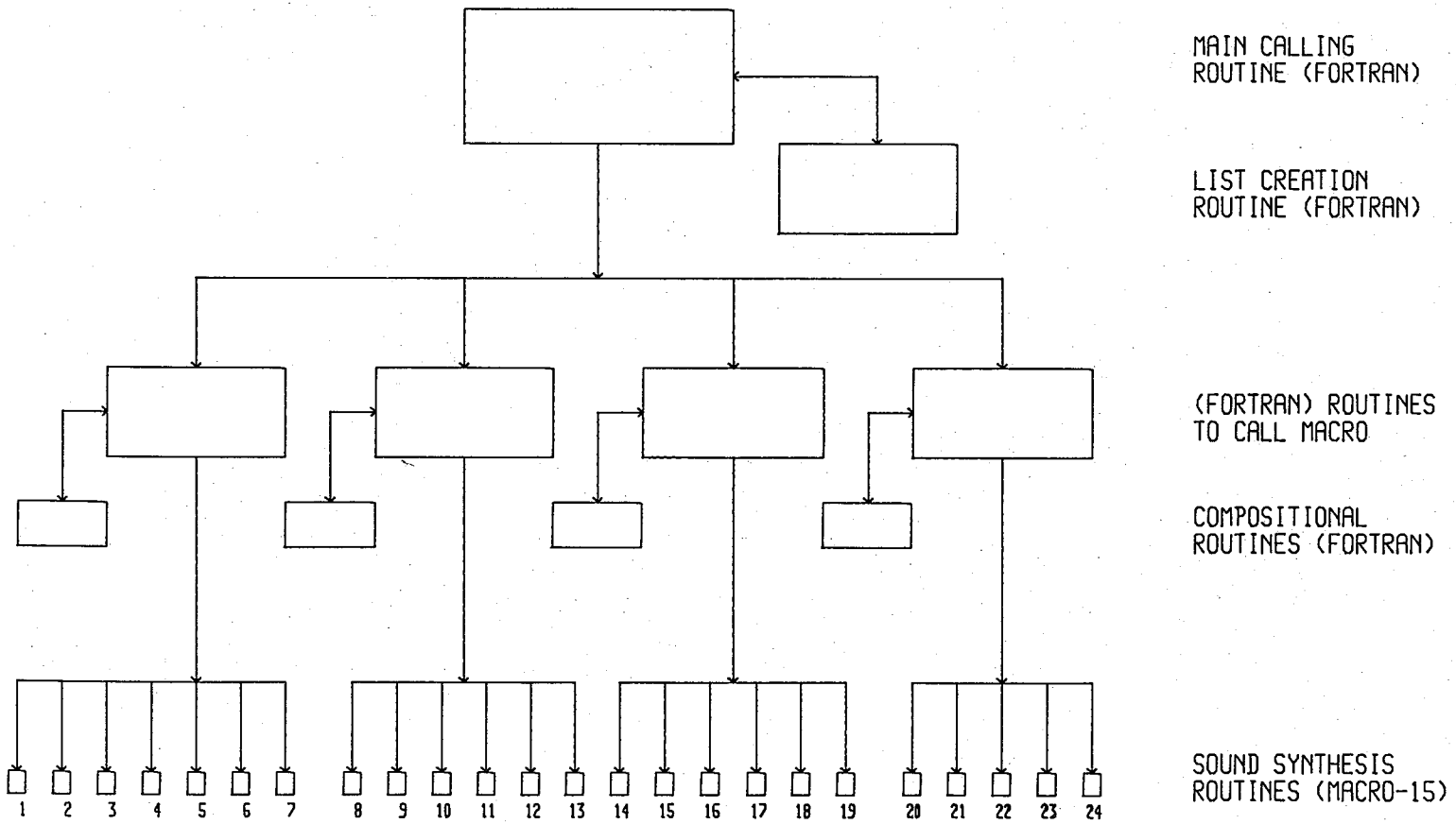
INTRODUCTION

The project which I have completed involves the use of the PDP-15 computer in the dual capacity of sound synthesis production and computer-aided compositional decision making in a real-time environment. Compositions that I have created in the 14 months of working on this project (actually 7 months as a student and 7 months as a project worker) include:

TAPEWALK I	*stereo tape*	*6' 50"*
TAPEWALK II	*stereo tape*	*6' 40"*
T'WHICH	*stereo tape*	*15' 20"*
SAAMBA	*stereo tape*	*19' 00"*

Both aspects of this work- the sound synthesis level and compositional level- are reflected in a modular approach to programming (the use of hierarchic subroutine structures) consisting of sound synthesis routines realized in MACRO-15 and higher level compositional routines realized in the FORTRAN language. The application of the two languages for these separate purposes seemed most practical since speed of computation is neccessary for sound synthesis (making MACRO essential) and FORTRAN can be aptly utilized for such things as matrix manipulation, sorting, input/output, etc.; all valuable for compositional purposes. (Refer to the following flowchart for a general outline of program structure and their relationships.)



MAIN CALLING ROUTINE (FORTRAN)

LIST CREATION ROUTINE (FORTRAN)

(FORTRAN) ROUTINES TO CALL MACRO

COMPOSITIONAL ROUTINES (FORTRAN)

SOUND SYNTHESIS ROUTINES (MACRO-15)

PREVIOUS EXPERIENCE

My past experience as a composer using the computer has been in two areas: (1) a hybrid environment, and (2) a MUSIC V type environment. The shortcomings inherent in the digital control of analog equipment (hybrid systems) and the slow turn around time of large mainframe systems (MUSIC V) have made my experiences here unique and have added further dimensions to my work in the field of computer music with the possibilities of real-time interactive digital systems.

GENERAL REMARKS

Before going into details, I feel it is important to point out that my work has not been aimed at the creation of any type of "system"; either a sound synthesis system, a compositional system, or any combination thereof. By system, I mean, software designed as user-oriented in a general sense. My programs have been written for my own personal use and many have been written for specific musical purposes rather than for any general intention. I have tried to keep the direction and scope of this project aimed at my personal musical goals; so that, as a group of programs the sum total of my work is completely open-ended; yet flexible and practical for my objectives. Practical considerations of musical intent from my point of view as a composer first and as a computer user second have governed my actions. Programs can serve only to give an idea of my approach to the computer, its resourses, and uses, for my compositions. Since programming is a means to an end, the final objective and object is a composition.

WORKING PROCEDURE

My working procedure has involved a great deal of heuristic activity. The interaction between composer and computer in a real-time environment can become very close. This does not seem unusual when the musician's relationship with, for example, the piano (another machine) is considered. The possibility of implementing a compositional idea, listening to the result, and having the potential to alter the result in a short amount of time enables one to form a relationship with the computer of an almost symbiotic nature, especially when the potential exits for altering the original idea and/or results. Futhermore, particularly when using stochastic procedures, the computer's interpretation of a musical idea can, in turn, effect and influence the composer's original idea so the man/machine alliance can become an enriching experience for a composer.

Historically, this heuristic approach has been an important working method for composers- especially in times of stylistic or technological flux- and allows for a great deal of experimentation and development that cannot take place in an environment of less immediacy in terms of compositional work and sounding result. (The example of Haydn at Esterhazy is obvious. Would the classical orchestra-basically still in use today- have developed as quickly from the Baroque ensemble without this type of working environment?)

Since input/output procedures are quite straightforward in FORTRAN I have usually employed a real-time score-like commentary of running, sounding programs which give various information on such things as: present variable values, locations within sections of programs, choices made by the computer, etc. Also, composer input while programs are sounding is possible. This allows for futher in depth interaction and man/machine communication. (Especially of value in a stochastic environment.) (See figure which follows.)

Note: A more detailed explanation of the heuristic working method I have outlined here will be given in connection with the written illustration of a specific program.

```
**NO NEW SORT**
       PAUZE********

'IWAIT'=    123

   LIST    JGRUP JCHO  INK   JCNT
   165     2     8     1     22
**PRIME**

**NO NEW SORT**
       PAUZE********

'IWAIT'=     11

   LIST    JGRUP JCHO  INK   JCNT
   165     2     8     2     23
**PRIME**

'LISTA'=      8

** NEW SORT **
   LIST    JGRUP JCHO  INK   JCNT
   100     1    16     2     24
**RETRO**

**NO NEW SORT**
***** COPY33 *****
'LIST'=    178

'JWH'=      3

'JWH'=      4

**NO NEW SORT**
   LIST    JGRUP JCHO  INK   JCNT
   178     2    16     1     26
**PRIME**

'LISTA'=      8

** NEW SORT **
       PAUZE********

'IWAIT'=    243

   LIST    JGRUP JCHO  INK   JCNT
   178     2     4     1     27
**RETRO**

**NO NEW SORT**
       PAUZE********

'IWAIT'=     57

   LIST    JGRUP JCHO  INK   JCNT
   178     1     4     2     28
**PRIME**

**NO NEW SORT**
```

```
   LIST     JGRUP JCHO  INK   JCNT
   178      1     4     1     29
**PRIME**

**NO NEW SORT**
        PAUZE********

'IWAIT'=     81

   LIST     JGRUP JCHO  INK   JCNT
   262      2     4     2     30
**RETRO**

'LISTA'=      8

** NEW SORT **
   LIST     JGRUP JCHO  INK   JCNT
   262      2     3     1     31
**PRIME**

**NO NEW SORT**
        PAUZE********

'IWAIT'=     43

   LIST     JGRUP JCHO  INK   JCNT
   278      1     3     1     32
**PRIME**

'LISTA'=      8

** NEW SORT **
        PAUZE********

'IWAIT'=    233

***** COPY3 *****
'LIST'=    189

'JWH'=       1

'JWH'=       2

**NO NEW SORT**
        PAUZE********

'IWAIT'=    232

***** COPY33 *****
'LIST'=    180

'JWH'=       3

'JWH'=       4

'LISTA'=     10

** NEW SORT **
        PAUZE********
```

OBSERVATIONS

One provocative idea that has arisen from my experiences is: just what are the limits and possibilities of machine choices (in terms of stochastic procedures)? In my experience, the constant composer interaction on all levels of composition seems not necessarily to negate the idea of random processes; but at least to alter what is meant by a random process involving the computer. If I repeatedly use the same seed value for random number generation and constantly shape and sculpt the sound output via the refinement of random choices until I am satisfied with a final, repeatable result that expresses my musical intent, then is there anything random about this result? This is meant as a rhetorical question, but it is thought provoking...

SOUND SYNTHESIS LEVEL

Concerning sound synthesis, 23 routines are used to achieve a diversity of timbres, spatial relationships, and number of sounding voices. (See the following chart for a more detailed description of the routines.)

In conjunction with some of the output routines, wavesforms can be operated on by 18 routines which act to sort, reorder, replace, and transform the individual samples of waveforms while sounding to add further diversity to the timbral possibilities. (See the second following chart for details concerning each of these routines.)

TABLE AND DESCRIPTION OF MACRO-15 PROGRAMS

I. TWO CHANNEL OUTPUT OF ONE VOICE WHICH TRANSFORMS ONE SOUND WAVEFORM INTO ANOTHER ACROSS THE DURATION OF A SOUND EVENT WHILE PANNING ACROSS TWO SPEAKERS AT THE SAME RATE.

1)	0W22	UNMODULATED OUTPUT
2)	0WW22	DISTORTION MODULATION
3)	0F22	FREQUENCY MODULATION
4)	0A22	AMPLITUDE MODULATION
5)	0L22	DELAY MODULATION
6)	0Y22	GLISSANDO
7)	0L101	RANDOM GLISSANDO

II. IDENTICAL TO (1.) WITH THE ADDED AVAILABILITY OF WAVEFORM TRANSFORMATION VIA SORTING, REPLACING, AND EXCHANGING ROUTINES ACROSS THE DURATION OF A SOUND EVENT.

8)	M0B1	UNMODULATED OUTPUT
9)	M0BF	FREQUENCY MODULATION
10)	M0BA	AMPLITUDE MODULATION
11)	M0BY	GLISSANDO
12)	M0BT	DELAY MODULATION

III. TWO VOICE OUTPUT OF INDEPENDENT SOUND EVENTS

13)	0IN3	UNMODULATED OUTPUT
14)	0FM3	FREQUENCY MODULATION
15)	0AM3	AMPLITUDE MODULATION
16)	0LAY3	GLISSANDI
17)	0IN33	DISTORTION MODULATION
18)	0LA45	RANDOM GLISSANDI

IV. FOUR VOICE OUTPUT OF INDEPENDENT SOUND EVENTS

19)	0IN4	UNMODULATED OUTPUT
20)	0IN44	DISTORTION MODULATION
21)	0IN45	INTERLEAVING RESONANCE
22)	0FM4	FREQUENCY MODULATION
23)	0AM4	AMPLITUDE MODULATION
24)	0LAY4	GLISSANDI

THE FOLLOWING PROGRAM CONTAINS 18 SORTING, REPLACING, AND EXCHANGING ROUTINES WHICH MANIPULATE SOUND SAMPLES PER PERIOD. THE ROUTINES ARE LISTED WITH A SHORT DESCRIPTION AND THE LINE NUMBER AT WHICH THEY ARE LOCATED IN THE FOLLOWING PROGRAM.

```
C       F5 *** WITH WAV2,OWL,MOB1,MOBF,MOBA,MOBY,MOBT****
        SUBROUTINE F5(LIST,JAM)
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        COMMON A(500,17),Y1(500),Y2(500),Y3(500),Y4(500),
        1S(500),Z(500)
        JAM2=JAM/2
        JAM1=JAM2/2
        JAM3=JAM1*3
        LISTX=LIST-1
        LIST2=LIST/2
        LIST4=LIST/4
        LIST5=LIST/5
555     JTOT=LIST
        JOUT=IALEA(1,9)
        JWFF=IALEA(1,10)
        JW=IALEA(5,17)
        IF(JOUT.EQ.9.AND.JWFF.LT.2)JW=IALEA(1,17)
        JSET=0
        JOVE=1
        IJOO=IALEA(1,10)
        IF(IJOO.EQ.3)JOVE=IALEA(2,4)
        LIST1=LIST
1017    DO 600 I=1,LIST
600     S(I)=A(I,JW)
        GO TO (1,1,1,1,1,11,11,11,111),JOUT
1       NPER=IALEA(1,4)
        MPER=NPER
        MFLAT=IALEA(1,20)
        IF(MFLAT.EQ.9)MPER=IALEA(1,4)
        L=IALEA(1,LIST4)
        LL=L
        JENV=(LIST+1)*NPER*JOVE/L
        KENV=(LIST+1)*MPER*JOVE/LL
        NENV=IALEA(5,15)
        JJJ=IALEA(1,20)
        IF(JJJ.EQ.9)GO TO 888
        IV=IALEA(100,200)
        DO 999 I=1,LIST
999     Y1(I)=A(I,NENV)/IV+1
        GO TO 599
888     DO 955 I=1,LIST
955     Y1(1)=A(I,NENV)
599     JSRT=IALEA(3,18)
        GO TO (300,301,302,304,305,306,307,308,309,310,
        1313,314,315,316,317,318,319,320),JSRT
11      NPER=IALEA(1,2)
        MPER=NPER
        IV=IALEA(100,200)
        MFLAT=IALEA(1,20)
        IF(MFLAT.EQ.9)MPER=IALEA(1,2)
        IN=IALEA(4,LIST4)
        L=IALEA(1,LIST4)
        IF(JOUT.EQ.6)L=IALEA(1,9)
        LL=L
        JENV=(LIST+1)*NPER*JOVE/L
        KENV=(LIST+1)*MPER*JOVE/LL
        NENV=IALEA(5,15)
        DO 944 I=1,LIST
944     Y1(1)=A(I,NENV)/IV+1
        JSRT=IALEA(1,10)
```

```
      GO TO (304,305,306,307,308,309,314,315,317,318),JSRT
111   NPER=IALEA(1,4)
      MPER=IALEA(1,4)
      IV=IALEA(100,200)
      IV1=IALEA(100,200)
      L=IALEA(1,LIST4)
      LL=IALEA(1,LIST4)
      JENV=(LIST)*NPER/L
      KENV=(LIST)*MPER/LL
      NENV=IALEA(5,15)
      NENV1=IALEA(5,15)
      DO 933 I=1,LIST
      Y1(I)=A(I,NENV)/IV+1
933   Y2(I)=A(I,NENV1)/IV1+1
      JSRT=IALEA(3,18)
      GO TO (300,301,302,304,305,306,307,308,309,310,
     1313,314,315,316,317,318,319,320),JSRT
300   IF(JW.EQ.5)GO TO 1014
      IF(JW.EQ.9)GO TO 1014
1013  DO 155 J=1,LIST
      DO 166 I=1,LISTX
      IF(S(I+1).GT.S(I))GO TO 166
      ISWAP=S(I+1)
      S(I+1)=S(I)
      S(I)=ISWAP
166   CONTINUE
      CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
     1JOVE)
155   CONTINUE
      GO TO 333
301   IF(JW.EQ.11)GO TO 1013
      IF(JW.EQ.12)GO TO 1013
1014  DO 255 J=1,LIST
      DO 266 I=1,LISTX
      IF(S(I+1).LT.S(I))GO TO 266
      ISWAP=S(I+1)
      S(I+1)=S(I)
      S(I)=ISWAP
266   CONTINUE
      CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
     1JOVE)
255   CONTINUE
      GO TO 333
302   IF(JW.EQ.1)GO TO 333
      DO 188 J=1,LIST
      JST0=S(1)
      DO 199 I=1,LISTX
199   S(1)=S(1+1)
      S(LIST)=JST0
      CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
     1JOVE)
188   CONTINUE
      GO TO 333
304   DO 216 J=1,LIST
      CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
     1JOVE)
      IF(S(J).GT.JAM3)GO TO 218
      IF(S(J).LE.JAM3)GO TO 219
218   S(J)=S(J)-JAM3
      GO TO 216
```

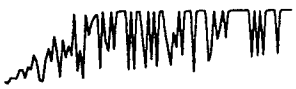
```
219     S(J)=S(J)+JAM1
216     CONTINUE
        GO TO 333
305     DO 220 J=1,LIST
        CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
        1JOVE)
        IF(S(J).GT.JAM2)GO TO 222
        IF(S(J).LE.JAM2)GO TO 223
222     S(J)=(S(J)-JAM3)+1
        GO TO 220
223     S(J)=S(J)+JAM1
220     CONTINUE
        GO TO 333
306     DO 209 J=1,LIST
        CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
        1JOVE)
        LIST1=LIST1-1
        IF(S(LIST1).GT.JAM3)S(LIST1)=S(LIST1)-JAM3
209     IF(S(LIST1).LE.JAM3)S(LIST1)=S(LIST1)+JAM1
        GO TO 333
307     DO 212 J=1,LIST
        CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
        1JOVE)
        LIST1=LIST1-1
        IF(S(LIST1).GT.JAM2)GO TO 214
        IF(S(LIST1).LE.JAM2)GO TO 215
214     S(LIST1)=S(LIST1)-JAM2
        GO TO 212
215     S(LIST1)=S(LIST1)+JAM2
212     CONTINUE
        GO TO 333
308     DO 205 J=1,LIST
        CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
        1JOVE)
        LIST1=LIST1-1
205     IF(S(LIST1).GT.JAM1/10)S(LIST1)=JAM
        GO TO 333
309     DO 207 J=1,LIST
        CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
        1JOVE)
207     IF(S(J).LT.JAM3+JAM1/2)S(J)=1
        GO TO 333
310     DO 203 J=1,LIST
        CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
        1JOVE)
        M=IALEA(1,LIST)
203     S(M)=IALEA(1,JAM2)
        GO TO 333
313     DO 500 J=1,LIST
        K=IALEA(1,LIST)
        LP=IALEA(1,LIST)
        ISWAP=S(K)
        S(K)=S(LP)
        S(LP)=ISWAP
        CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
        1JOVE)
500     CONTINUE
        GO TO 333
314     IF(JW.GT.1.AND.JW.LT.4)GO TO 333
        IF(JW.EQ.10)GO TO 333
```

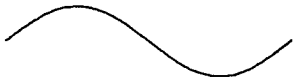
```
      IF(JW.EQ.17)GO TO 333
      I=LIST/2+1
      I1=I-1
      DO 403 J=1,I1
      ISWAP=S(J)
      S(J)=S(I-J)
      S(I-J)=ISWAP
      ISWAP=S(LIST1-J)
      S(LIST1-J)=S(I1+J)
      S(I1+J)=ISWAP
      CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
     1JOVE)
403   CONTINUE
      GO TO 333
315   IF(JW.GT.5.AND.JW.LT.9)GO TO 333
      IF(JW.GT.12.AND.JW.LT.17)GO TO 333
      J2=LIST/2
      DO 405 J=1,J2
      ISWAP=S(J)
      S(J)=S(LIST1-J)
      S(LIST-J)=ISWAP
      CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
     1JOVE)
405   CONTINUE
      GO TO 333
316   DO 407 J=1,LIST
      K=IALEA(1,LIST)
      ISWAP=S(J)
      S(J)=S(K)
      S(K)=ISWAP
      CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
     1JOVE)
407   CONTINUE
      GO TO 333
317   IF(JW.EQ.1)GO TO 333
      IF(JW.GT.2.AND.JW.LT.5)GO TO 333
      LISS2=LIST/2
      LISP2=(LIST/2)-1
      DO 409 I=1,LISS2
      LISP2=LISP2+1
      ISWAP=S(I)
      S(I)=S(LISP2)
      S(LISP2)=ISWAP
      CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
     1JOVE)
409   CONTINUE
      GO TO 333
318   IF(JW.EQ.5)GO TO 333
      IF(JW.GT.0.AND.JW.LT.4)GO TO 333
      IF(JW.EQ.9.OR.JW.EQ.17)GO TO 333
      DO 411 J=1,LIST
      LIST1=LIST1-1
      IF(S(J+1).GT.S(J))GO TO 412
      ISWAP=S(J)
      S(J)=S(J+1)
      S(J+1)=ISWAP
412   IF(S(LIST1).GT.S(LIST1-1))GO TO 413
      ISWAP=S(LIST1)
      S(LIST1)=S(LIST1-1)
      S(LIST1-1)=ISWAP
```

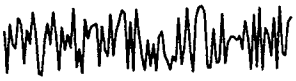
```
413     CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
        1JOVE)
411     CONTINUE
        GO TO 333
319     DO 415 I=1,LIST
        Z(I)=S(I)
415     S(1)=1
        DO 416 J=1,LIST
        S(J)=Z(J)
        CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
        1JOVE)
416     CONTINUE
        GO TO 333
320     IF(JW.EQ.10)GO TO 333
        MNO=IALEA(5,12)
        DO 419 J=1,LIST
        IF(A(J,MNO).LT.S(J))S(J)=A(J,MNO)
        CALL OWL(S,NPER,MPER,L,LL,LIST,JTOT,JENV,KENV,Y1,Y2,JSET,JOUT,IN,
        1JOVE)
419     CONTINUE
        GO TO 333
333     CONTINUE
        RETURN
        END
```

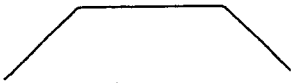
USE OF STORED LISTS

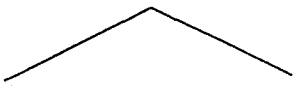
There are 17 stored lists used for a variety of purposes: (1) waveforms, (2) envelopes, (3) modulators on a timbral, rhythmic, or pitch level (i.e. in the defining of duration/rhythm; pitch/fundamental frequency; glissandi; distortion modulation; delay modulation; location modulation; frequency modulation; and amplitude modulation). The 17 lists can be recalculated rapidly in real- time to allow for the use of different list sizes and scale factorings. (Refer to the following figure of the lists and the program which calculates them.)











```
C       WAV2 ******** 17 WAVES
        SUBROUTINE WAVE(LIST,JAM)
        INTEGER A
        COMMON A(500,17)
        LIST2=LIST/2
        LIST4=(LIST/4)*3
        LIST8=(LIST/8)*7
        XLIST=LIST
        DD=6.28318507/XLIST
        JAM2=JAM/2
        XJAM2=JAM2
        JAM1=JAM2/2
        JAM3=JAM1*3
        JAMT=JAM*2
        JAZ=JAM*20
        LOS=JAM3
        LOS1=JAM
        L8=LIST/5
        L=0
        M=LIST/2+1
        M=-M
        LISTX=LIST-1
        N=-1
        KTRI=JAMT/LIST
        KT=-KTRI+1
        KK=JAM/LIST
        K=0
        IK=JAM+KK
        DO 11 I=1,LIST
        IK=IK-KK
        A(I,11)=IK
        CC=I
        A(I,10)=SIN(CC*DD)*XJAM2+JAM2+1
        IF(I.LE.LIST2)A(I,17)=1
        IF(I.GT.LIST2)A(I,17)=JAM
        K=K+KK
        A(I,5)=K
        A(I,3)=IALEA(1,JAM)
        A(I,1)=(((A(I,3)/200)+1)*A(I,5))/5
        IF(A(I,3).GT.JAM1)GO TO 20
        IF(A(I,3).LE.JAM1)GO TO 30
20      A(I,2)=JAM
        GO TO 40
30      A(I,2)=1
40      KT=KT+KTRI
        IF(KT.GT.JAM)KTRI=-KTRI
        A(1,7)=KT
        KT2=KT*2
        IF(KT.GE.JAM2)KT2=JAM
        A(I,14)=KT2
        KT4=KT*4
        IF(KT.GE.JAM1)KT4=JAM
        A(I,15)=KT4
        KT3=KT*1.333
        IF(KT.GE.JAM3)KT3=JAM
        A(I,13)=KT3
        KT33=KT*2.5
        IF(KT.GE.JAM3)KT33=JAM
        IF(KT33.GT.JAM)KT33=KT33-JAM
        A(I,16)=KT33
```

```
      L=L+1
      M=M+1
      A(I,8)=M*M
      N=N+1
      A(I,6)=LISTX*N-(N*N)+1
      LAS=IALEA(LOS,LOS1)
      IF(N.GT.L8)LOS=JAM2
      IF(N.GT.L8)LOS1=JAM3
      IF(N.GT.L8*2)LOS=JAM1
      IF(N.GT.L8*2)LOS1=JAM2
      IF(N.GT.L8*3)LOS=1
      IF(N.GT.L8*3)LOS1=JAM1
      IF(N.GT.L8*4)LOS=JAM2-2
      IF(N.GT.L8*4)LOS1=JAM2+2
11    A(1,4)=LAS
      A(LIST,16)=JAM
      KITH=1
      A(1,9)=1
      DO 54 I=1,LISTX
      A(I+1,9)=A(I,9)+KITH
54    KITH=KITH+1
      LUKH=JAZ/A(1,8)
      LUKD=JAZ/A(LIST2,6)
      LUKS=JAZ/A(LIST,9)
      DO 51 I=1,LIST
      A(I,8)=(A(I,8)*LUKH)/20+1
      A(1,6)=(A(I,6)*LUKD)/20+1
51    A(I,9)=(A(I,9)*LUKS)/20+1
      II=1
      DO 22 I=LIST,1,-1
      A(II,12)=A(I,9)
22    II=11+1
      RETURN
      END
```

COMPOSITIONAL LEVEL

Many of the ideas and processes involved on the lower level of composition (sound synthesis) intersect and parallel compositional procedures of a higher level. This is an important characteristic of my work which involves the establishment of connections among higher and lower levels of composition and music. My attitude of diversity in regard to timbre is reflected in a variety of routines pertaining to the compositional level. As an overview the following ideas are developed: (Detailed descriptions of programs used for specific compositions are given later.)

(1) stochastic (probabalistic) choices, Markov chaining, random weighting (brownian, etc.);
(2) tendencies (both stochastic and composer detailed), masking of variable ranges to produce directional tendencies (i.e. movement from pitched sound to noise across various modulations of timbre during an event sequence);
(3) algorithms (i.e. exponential functions, etc.) to control various parameters and structures;
(4) sorting, reordering, and replacing routines to act on sound event strings syntactically (i.e. sorting of a group of sound events having random pitch ordering into a directional pitch sequence);
(5) transformations of sequences of sound events with various tied and/or untied relationships among parameters.

"TWALK" is a compositional program that elaborates on the simple 'random walk' which is a constrained stochastic procedure defined as follows: given point (n) on a line, the only possible choices which can succeed point (n) are the points (n-1) or (n+1). The probability of either choice is (.5).

"TWALK" was used to create the composition "TAPEWALK I" in which 100 sound events have been ordered in an array and can be accessed via their address location in the computer. These sound events have all parameters tied (e.g. whenever a particular address is accessed pitch, duration, amplitude, envelope, etc. are always the same). Two locations are reserved for rests and one location is an exception to the rule of tied parameters. This exception allows for the transformation of parameters of the event each time it is chosen.

Two opposing operations take place in the course of the program. Probabilities are set at the initial values of (.3) and (.7). If the array is imagined as a horozontial line with a pointer then this initial probability setting will cause the pointer to generally move in the direction of the (.7) weighting (to the right). When a threshold is reached (the end of the array) then the probabilities are reversed to (.7) and (.3), which causes the pointer to be directed towards the left in the opposite direction until a threshold is again detected (the beginning of the array) at which point the probabilities are switched again. In this way the pointer traverses the range of the array back and forth while the probabilities themselves (which are variables) change gradually from the initial values of (.3) and (.7) to the final and equally probable values of (.5) and (.5). This change in the probability values produces a tendency towards more and more repetition of individual events and strings of events. Simultaneously, the possibility for location choice is increased through the course of the program from the initial possibilities of (n-1) and (n+1) to (n-12) and (n+12). This is a tendency towards less repetition. These two processes,

one directed towards more repetition and the other away from repetition, interact in a dynamic manner because of their opposite yet completely interrelated purpose of controlling the amount of repetition of single events and event strings.

The program ends when the probabilities become balanced at (.5) each.

Basically the heuristics employed in the creation of this program (and composition) mainly involved the alteration of the variable values mentioned above. I will attempt a reconstruction of the interactive experiences which resulted in this program, while keeping in mind the somewhat hypothetical nature of any attempt at reconstruction of past events and the detail required in such an undertaking.

The program originally allowed for the possibilities involved in the basic definition of a 'random walk' mentioned in the first paragraph above. It is easy to see that the small choice range and equal probabilities for those choices gives a repetitious result- which could prove interesting in particular application (i.e. the case of a single parameter choice for sound events); but in the case of sound event choice with all parameters tied was too repetitious. My first impulse was to increase the size of the choice range, but this gave the same repetitious situation- only over a longer time duration. I returned to the original choice range and altered the probabilities for choices to a more imbalanced state. This proved interesting when the probabilities were allowed to reverse themselves upon a threshold detection allowing for greater flexibility (otherwise the pointer gets 'stuck' at one end of the event list). Yet even these results gave similar variations for each back-and-forth traversal of the array; so that a staticity resulted over time. Increasing the choice range again gave a more dynamic result in conjunction with reversing the imbalanced probability factors. Yet, still, the repetition necessitated the use of tendency masks to allow for variable alteration over time in order to control repetition more effectively. Experimentation took place to establish workable minimum and maximum values for the two variable sets- choice range and probability- separately. Then they were futher refined in relation

to each other. This required a great deal of time making just slight modifications until the final result was arrived at. This is a somewhat labourious task; but the convenience of altering values via the switch register and/or read input statements while a program is running can prove very effective. The one sound event not having all parameters tied is a minor detail that resulted from and gives credence to this interactive approach where flexibility in attaining the final result is evident.

Hopefully, this detailed explanation of my personal, intuitive working method has not been too tedious. This example should suffice to give an idea of my heuristic approach to using the computer for the creation of music.

```
C       TWALK
C       TO CALL F2,F3,F4,F5
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        INTEGER SEED(120)
        COMMON A(500,17),Y1(500),Y2(500),Y3(500),Y4(500),
        1S(500),Z(500)
9090    WRITE(4,786)
786     FORMAT(' SEED VALUE?')
        READ(4,)JSEED
        CALL RANDOM(JSEED,X1)
        DO 135 I=1,10
        WRITE(4,)I
135     CONTINUE
        DO 22 I=1,120
22      SEED(I)=IALEA(1,10000)
        JBIT=1
        JCNT=1
        ICNT=1
        KAS1=700
        KAS2=300
        KASS=KAS1
        I0=60
321     LIST=IALEA(100,150)
        LIST=160
        WRITE(4,)LIST
        JAM=4000
        CALL WAVE(LIST,JAM)
5555    CALL RANDOM(SEED(I0),X1)
        IF(ICNT.LT.200)GO TO 999
        IF(I0.NE.67)GO TO 543
        IPER=4
        JCHOO=6
        GO TO 100
543     IPER=IALEA(1,1)
        JCHOO=IALEA(1,6)
100     GO TO (2,2,2,2,3,4),JCHOO
2       CALL F2(LIST)
        GO TO 999
3       CALL F3(LIST,IPER)
        GO TO 999
4       CALL F4(LIST,IPER)
        GO TO 999
5       CALL F5(LIST,JAM)
        GO TO 999
999     ICNT=ICNT+1
        JCNT=JCNT+1
        IF(JCNT.LT.100)GO TO 1929
        JCNT=1
        WRITE(4,)JBIT,KASS
        JBIT=JBIT+1
1929    CALL RANDOM(ICNT,X1)
        JHAF=IALEA(1,1000)
        IF(I0.GT.10)GO TO 149
        KAS2=KAS2+4
        KASS=KAS2
        GO TO 19
149     IF(I0.LT.110)GO TO 49
        KAS1=KAS1-4
        KASS=KAS1
        GO TO 29
```

```
49      IF(JHAF.LT.KASS)GO TO 29
19      IO=IO+IALEA(1,JBIT)
        GO TO 39
29      IO=IO-IALEA(1,JBIT)
39      IF(KASS.GT.429.AND.KASS.LT.571)GO TO 9090
        IF(IO.EQ.37.OR.IO.EQ.87)GO TO 6666
        GO TO 5555
6666    JREST=IALEA(5,40)
        DO 1918 I=1,JREST
        WRITE(4,776)I
776     FORMAT('+',I4)
1918    CONTINUE
        GO TO 5555
        STOP
        END
```

"MARK" is the only compositional program which does not produce a sounding result. The output from "MARK" is used as input to another program, "TMARK". "MARK" created two files on disc. One file contains user input specifying in a matrix the probability weighting of a Markovian chain of events. Then the program creates a trail or sequence of events (the second disc file) dependent on the weighting specifications and sequence possibilities dictated by the user created matrix. The Markov chain is of order 11 and the 11 'events' are actually compositional subroutines. The trail is used by "TMARK" to call these subroutines, thereby giving overall formal characteristics to the composition "SAAMBA". Certain subroutines cannot follow others; specific routines generally (in a probabilistic sense) precede and follow other routines depending on the matrix; so that, a particular matrix can serve as a powerful formal tool in the ordering of event groups (as defined in a subroutine called).
A list of the subroutines called by "TMARK" with a brief explanation of their specific characteristics follows:

(1) "C10" : four voices, calls the compositional subroutine "PCH" to control the contour of pitches in an event sequence. Nine countours are possible ranging from a simple ascending pitch tendency to other more complex tendencies involving various thresholds and controls.

(2) "C20" : two voices, calls a subroutine "H52" which rescales values from the 17 lists used, so that the lists can be utilized for controlling pitch and duration.

(3) "C21" : one voice with location modulation which also calls the subroutine "H52" mentioned above.

(4) "C11" : two voices, similar to "C20" with the additional control of articulation.

(5) "C30" : two voices, uses the subroutine "H52" and also divides the event sequence into sections over time introducing a directional tendency controlling timbre. The tendency moves from pitched sound to noise over six timbral areas.

(6) "C40" : merely the reverse of "C30"; moving from noise to pitch across an event sequence.

(7) "C21VL" : one voice with directional modulation, which takes a short event sequence and transforms it six times focusing on timbre involving a tendency from pitch to noise.

(8) "C21FH" : similar to "C21VL" except that the tendency is from noise to pitch.

(9) "C50" : two voices, calls one output routine which produces a unique type of random modulation of pitches on a short event sequence.

(10) "CF45" : four voices, produces events of large duration in a pitch cluster.

(11) "SIL" : no voices, produces silence of a chosen duration within a certain range.

The matrix used and the trail produced follow. (The matrix values are in integer form, 50 =(.5).)

(NEXT EVENT)

(CURRENT EVENT)	C10	C20	C21	C11	C30	C40	C21UL	C21FH	CS0	CF4F	SIL
C10	6	4	4	4	0	0	30	0	14	18	20
C20	6	4	4	4	0	0	0	30	14	18	20
C21	6	4	4	4	30	0	0	0	14	18	20
C11	6	4	4	4	0	30	0	0	14	18	20
C30	0	0	0	0	0	0	0	0	33	33	34
C40	0	0	0	0	0	0	0	0	33	33	34
C21UL	0	0	0	0	0	0	0	0	33	33	34
C21FH	0	0	0	0	0	0	0	0	33	33	34
CS0	0	0	0	0	0	0	0	0	33	33	34
CF4F	20	20	20	20	0	0	0	0	0	0	20
SIL	20	20	20	20	0	0	0	0	0	20	0

TRAIL = 9,11,10,3,5,10,2,11,3,5,10,2,10,11,1,11,3,10,1,7,9,11,
2,4,11,10,11,10,3,10,2,8,11,3,5,10,2,11,1,7,11,10,1,9,10,2,8,
9,10,1,9,11,4,11,10,3,5,9,10,4,3,1,9,10,1,11,1,11,3,5,10,4,4,
9,11,4,6,10,2,11,10,11,1,1,9,11,2,8,10,4,3,11,10

(These numbers refer to the sequence of subroutine calls made.)

Eight other programs were used in the first section of the composition "SAAMBA". These include:

(1) "F44","F444","SHORT" : four voices with an algorithm for exponential control of duration which produces a clearly defined tendency.

(2) "FTOT22","FTAT22","NPCH" : two voices with a directional tendency from noise to pitched sounds simultaneously with a decrease in the possible pitches chosen via masking.

(3) "FBUBB","FBUBA" : two voices, a random sequence of sound events is ordered via a bubble sort into ascending and decending strings according to their pitches. A small percentage, or margin, for random alteration of the strings as they are being ordered is allowed for by way of a weighting specification.

```
C       MARK*******
        IMPLICIT INTEGER (A-W)
        COMMON A(11,11),B(125),D(11)
1234    WRITE(4,785)
785     FORMAT(' SEED VALUE?,NUMBER OF NODES?')
        READ(4,)JSEED,MAX
        WRITE(9,)JSEED,MAX
        CALL RANDOM(JSEED,X1)
        IF(JWW.EQ.1)GO TO 747
C
C       *****INPUT SECTION*****
C
111     WRITE(4,786)
786     FORMAT(' INPUT MATRIX VALUES')
        DO 39 I=1,MAX
39      READ(4,)(A(I,J),J=1,MAX)
747     WRITE(4,787)
787     FORMAT(' HERE IS THE TABLE...')
        DO 49 I=1,MAX
49      WRITE(9,788)(A(I,J),J=1,MAX)
788     FORMAT(11(I4))
        WRITE(4,789)
789     FORMAT(' ALL IS O.K.?')
        WRITE(4,790)
790     FORMAT(' YES=1,NO=0')
        READ(4,)ANS
        IF(ANS.LT.1)GO TO 111
C
C       *****CALCULATE % ******
C
        DO 98 I=1,MAX
98      D(I)=0
        DO 89 J=1,MAX
        DO 89 I=1,MAX
89      D(J)=A(I,J)+D(J)
        DO 109 I=1,MAX
109     D(I)=D(I)/MAX
        WRITE(9,792)
792     FORMAT(' THEORETICAL PERCENTAGES:')
        WRITE(9,793)(D(I),I=1,MAX)
793     FORMAT(11(I4))
C
C       *****FIGURE PATH*****
C
        WRITE(9,797)
797     FORMAT(' STARTING NODE:')
        R=IALEA(1,MAX)
        B(1)=R
        WRITE(9,)R
        WRITE(9,798)
798     FORMAT(' NETWORK PATH:')
        DO 59 IK=2,121
        CH=IALEA(1,100)
        TOT=0
10      DO 69 C=1,MAX
        IF(A(R,C).EQ.0)GO TO 69
        TOT=A(R,C)+TOT
        IF(CH.LE.TOT)GO TO 11
69      CONTINUE
11      B(IK)=C
```

```
      R=C
59    CONTINUE
      WRITE(9,791)(B(I),I=1,121)
791   FORMAT(11(I3))
C
C     ***** # OF EACH EVENT *****
C
      DO 149 I=1,MAX
149   D(I)=0
      DO 139 I=1,MAX
      DO 139 J=1,121
139   IF(B(J).EQ.1)D(I)=D(I)+1
      WRITE(9,794)
794   FORMAT(' ACTUAL PERCENTAGES:')
      WRITE(9,795)(D(I),I=1,MAX)
795   FORMAT(11(I4))
      WRITE(9,799)
799   FORMAT(////)
C
C     *****BRANCH TO ? *****
C
      WRITE(4,796)
796   FORMAT(' 1=NEW SEED'/' 2=NEW MATRIX'/
     1' 3=NEW SEED AND MATRIX'/' 4=STOP')
      READ(4,)JWW
      IF(JWW.EQ.2)GO TO 111
      IF(JWW.EQ.4)GO TO 4321
      GO TO 1234
4321  STOP
      END
```

```
C       TMARK*********WITH MARK ALSO
        INTEGER A,Y1,Y2,Y3,Y4,B
        INTEGER C(121)
        COMMON A(350,17),Y1(350),Y2(350),Y3(350),Y4(350),B(100,13)
        WRITE(4,754)
754     FORMAT(' LOAD TRAIL PAPERTAPE')
        WRITE(4,786)
786     FORMAT(' SEED VALUE?')
        READ(4,)JSEED
        CALL RANDOM(JSEED,X1)
        CALL HS2
C*********************************
        READ(5,709)(C(I),I=1,121)
709     FORMAT(I4)
        WRITE(4,711)(C(1),I=1,121)
711     FORMAT(11(I5))
        PAUSE 1
C*********************************
        LH=1
        ML=7
        MH=13
        LIST=IALEA(100,300)
        JAM=4000
        CALL WAVE(LIST,JAM)
        DO 99 I=1,121
        WRITE(4,)I
        JCH00=C(I)
        GO TO (1,2,3,4,5,6,7,8,9,10,11),JCH00
1       CALL C10(LIST)
        GO TO 99
2       CALL C20(LH,ML,MH,LIST)
        GO TO 99
3       CALL C21(LIST)
        GO TO 99
4       CALL C11(LIST)
        GO TO 99
5       CALL C30(LIST)
        GO TO 99
6       CALL C40(JSEED,LIST)
        GO TO 99
7       CALL C21VL(LIST)
        GO TO 99
8       CALL C21FH(LIST)
        GO TO 99
9       CALL C50(LIST)
        GO TO 99
10      CALL CF4F(LIST)
        GO TO 99
11      CALL SIL
        GO TO 99
99      CONTINUE
        STOP
        END
```

```
      SUBROUTINE C10(LIST)
C     C10
C     F44************************
C     WITH PCH********
C     WITN OIN4,OIN44,OIN45,OFM4,OAM4,OLAY4
      INTEGER FMIN,FMIN1,FMIN2,FMIN3,AMIN,AMIN1,AMIN2,AMIN3
      INTEGER A,Y1,Y2,Y3,Y4,B
      COMMON A(350,17),Y1(350),Y2(350),Y3(350),Y4(350),B(100,13)
      WRITE(4,786)
786   FORMAT(' C10')
321   LIST=IALEA(100,300)
      JAM=4000
      CALL WAVE(LIST,JAM)
      LIST2=LIST/2-10
      LIST4=LIST/2
      LIST5=LIST/5
      JWHI=LIST2
3212  JAMP=IALEA(25,45)
      JAAP=JAMP
      LWH1=0
      L=0
      JSWI=0
      JPCH=IALEA(1,12)
      LONG=IALEA(1,100)
      JSTX=0
      WRITE(4,)LIST,JPCH,LONG
555   CALL PCH(LWHI,LIST4,LIST2,L,JPCH,JWHI,JSWI)
      IF(LONG.LT.50.AND.JSTX.EQ.1)GO TO 678
      IV=IALEA(100,100)
      IV1=IALEA(100,100)
      IV2=IALEA(100,100)
      IV3=IALEA(100,100)
      JSWQ=IALEA(1,20)
      IF(JSWQ.GT.1)GO TO 5555
      JW=IALEA(1,17)
      JW1=IALEA(1,17)
      JW2=IALEA(1,17)
      JW3=IALEA(1,17)
      GO TO 666
5555  JW=IALEA(5,17)
      JW1=IALEA(5,17)
      JW2=IALEA(5,17)
      JW3=IALEA(5,17)
666   NENV=IALEA(5,15)
      NENV1=IALEA(5,15)
      NENV2=IALEA(5,15)
      NENV3=IALEA(5,15)
      JJJ=IALEA(1,40)
      IF(JJJ.NE.9)GO TO 111
      IV=1
      IV1=IV
      IV2=IV
      IV3=IV
111   DO 11 I=1,LIST
      Y1(I)=A(I,NENV)/IV+1
      Y2(I)=A(I,NENV1)/IV1+1
      Y3(I)=A(I,NENV2)/IV2+1
11    Y4(I)=A(I,NENV3)/IV3+1
678   L=L+4
      LL=L+1
```

```
      LLL=L-1
      LLLL=L+2
      LO=IALEA(75,100)
      IGH=3000/L
      IF(JAAP.LT.28)IGH=10*L
      IF(IGH.LT.125)IGH=125
      NPER=IALEA(LO,IGH)
      MPER=IALEA(LO,IGH)
      JPER=IALEA(LO,IGH)
      KPER=IALEA(LO,IGH)
      JENV=NPER/L
      KENV=MPER/LL
      LENV=JPER/LLL
      MENV=KPER/LLLL
      IF(JJJ.LT.7.AND.JSWO.NE.10)GO TO 4321
      JSWO=IALEA(1,15)
      IF(JSWO.GT.9)JSWO=1
      IF(JJJ.EQ.9)JSWO=10
4321  GO TO (222,222,1111,1010,1010,444,444,333,333,777),JSWO
222   CALL OUT17(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
      GO TO 999
777   CALL OUT18(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
      GO TO 999
1010  CALL OUT19(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
      GO TO 999
333   FMIN=IALEA(1,LIST4)
      FMIN1=IALEA(1,LIST4)
      FMIN2=IALEA(1,LIST4)
      FMIN3=IALEA(1,LIST4)
      CALL OUT20(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4,FMIN,FMIN1,FMIN2,FMIN3)
      GO TO 999
444   AMIN=IALEA(8,LIST4)
      AMIN1=IALEA(8,LIST4)
      AMIN2=IALEA(8,LIST4)
      AMIN3=IALEA(8,LIST4)
      CALL OUT21(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4,AMIN,AMIN1,AMIN2,AMIN3)
      GO TO 999
1111  CALL OUT22(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
999   JAMP=JAMP-1
      JSTX=1
      IF(JAMP.GT.0)GO TO 555
      JUPP=IALEA(1,100)
      IF(JUPP.LT.20)GO TO 3212
      RETURN
      END
```

```
      SUBROUTINE PCH(LWHI,LIST4,LIST2,L,JPCH,JWHI,JSWI)
      JTOP=IALEA(1,3)
      JTOP2=JTOP+JTOP
      GO TO (1,2,3,4,5,6,7,8,9,1,2,8),JPCH
1     L=IALEA(LIST4,LIST2)
      LWHI=IALEA(1,30)
      IF(LWHI.LT.4)L=IALEA(2,12)
      GO TO 999
2     JTOP=IALEA(4,8)
      LWHI=LWHI+1
      IF(LWHI.GE.JTOP)LWHI=0
      IF(LWHI.EQ.0)L=IALEA(2,12)
      IF(LWHI.GE.1)L=IALEA(LIST4,LIST2)
      GO TO 999
3     LWHI=LWHI+JTOP
      IF(LWHI.GT.LIST2)LWHI=LIST2
      L=LWHI
      GO TO 999
4     JWHI=JWHI-JTOP
      IF(JWHI.LT.6)JWHI=IALEA(2,5)
      L=JWHI
      GO TO 999
5     LWHI=LWHI+JTOP2
      JWHI=JWHI-JTOP2
      IF(LWHI.GT.LIST4)LWHI=LIST4
      IF(JWHI.LT.LIST4)JWHI=LIST4
      L=IALEA(LWHI,JWHI)
      GO TO 999
6     JWHI=JWHI-JTOP2
      IF(JWHI.LT.6)JWHI=5
      L=IALEA(2,JWHI)
      GO TO 999
7     LWHI=LWHI+JTOP
      IF(LWHI.GT.LIST4)LWHI=LIST4-8
      L=IALEA(LWHI,LIST4)
      GO TO 999
8     LWHI=LWHI+JTOP
      JWHI=JWHI-JTOP
      IF(LWHI.GT.LIST4)LWHI=LIST4
      IF(JWHI.LT.LIST4)JWHI=LIST4
      JSWI=JSWI+1
      IF(JSWI.EQ.2)JSWI=0
      L=JWHI
      IF(JSWI.EQ.0)L=LWHI
      GO TO 999
9     IF(LWHI.GT.LIST2)JSWI=1
      IF(LWHI.LE.JTOP2)JSWI=0
      IF(JSWI.EQ.0)LWHI=LWHI+JTOP2
      IF(JSWI.EQ.1)LWHI=LWHI-JTOP2
      L=LWHI
      GO TO 999
10    L=IALEA(1,LIST4)
      GO TO 999
999   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE C20(LH,ML,MH,LIST)
C     C20
C     F3*******************
C     FVIV2*****WITH B52*******
C     WITH WAV2,0IN3,0FM3,0AM3,0LAY3,0IN33
      INTEGER FMIN,FMIM,AMIN,AMIM
      INTEGER HIGH
      INTEGER A,Y1,Y2,Y3,Y4,B
      COMMON A(350,17),Y1(350),Y2(350),Y3(350),Y4(350),B(100,13)
      WRITE(4,786)
786   FORMAT(' C20')
321   LIST=IALEA(100,300)
      JAM=4000
      CALL WAVE(LIST,JAM)
      LIST2=LIST/2
      LIST4=LIST/4
      LIST5=LIST/5
      INC=IALEA(1,13)
      INC1=IALEA(1,13)
      IJ=IALEA(ML,MH)
      IPER=IALEA(1,4)
      IPER1=IALEA(1,4)
      GO TO(1,1,1,2),IPER
1     IGH=100
      GO TO 555
2     IGH=500
555   GO TO(13,13,13,23),IPER1
13    IGH1=100
      GO TO 5553
23    IGH1=500
5553  WRITE(4,)LIST,INC,INC1,IJ
5555  DO 535 IZ=1,100,IJ
      JW=IALEA(5,17)
      JW1=IALEA(5,17)
6666  NENV=IALEA(5,15)
      NENV1=IALEA(5,15)
      IV=IALEA(100,200)
      IV1=IALEA(100,200)
      JJJ=IALEA(1,30)
      IF(JJJ.NE.9)GO TO 111
      IV=1
      IV1=1
111   DO 11 I=1,LIST
      Y1(I)=A(I,NENV)/IV+1
11    Y2(I)=A(I,NENV1)/IV1+1
      L=B(IZ,INC)+1
      LL=B(IZ,INC1)+1
      HIGH=IALEA(1,10)
673   NPER=L*L
      MPER=LL*LL
      IF(L.GT.11)NPER=L*(L-LH)
      IF(LL.GT.11)MPER=LL*(LL-LH)
      IF(L.LT.11)NPER=L*(L*LH)
      IF(LL.LT.11)MPER=LL*(LL*LH)
      IF(NPER.LT.L)NPER=L
      IF(MPER.LT.LL)MPER=LL
      JENV=NPER/L
      KENV=MPER/LL
      JSWI=IALEA(1,13)
      IF(JSWI.GT.10)JSWI=1
```

```
      IF(JJJ.EQ.9)JSWI=12
      IF(JJJ.EQ.3)JSWI=11
      GO TO (222,222,222,222,333,333,333,444,444,444,666,777),JSWI
222   CALL OUT12(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
      1JENV,KENV,Y1,Y2)
      GO TO 999
333   FMIN=L+1
      FMIM=LL-1
      CALL OUT13(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
      1JENV,KENV,Y1,Y2,FMIN,FMIN)
      GO TO 999
444   AMIN=L+1
      AMIM=LL-1
      CALL OUT14(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
      1JENV,KENV,Y1,Y2,AMIN,AMIN)
      GO TO 999
666   CALL OUT15(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
      1JENV,KENV,Y1,Y2)
      GO TO 999
777   CALL OUT16(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
      1JENV,KENV,Y1,Y2)
      GO TO 999
999   CONTINUE
535   CONTINUE
      LH=LH+5
      ML=ML-1
      MH=MH-1
      IF(ML.LT.2)ML=2
      IF(MH.LT.6)MI=6
      RETURN
      END
```

```
      SUBROUTINE H52
C     H52****** SUB WITH FH AND FH1
C     FBUBB WITH WAV2 ** 0W22,0WW22,0F22,0A22,0L22,0Y22
      INTEGER A,Y1,Y2,Y3,Y4,B
      COMMON A(350,17),Y1(350),Y2(350),Y3(350),Y4(350),B(100,13)
321   LIST=100
      JAM=4000
      CALL WAVE(LIST,JAM)
      DO 535 J=1,13
      DO 535 I=1,LIST
      B(I,J)=A(I,J+4)/80+1
535   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE C21(LIST)
C     C21
C     FXIX2 WITH WAV2 ** 0W22,0WW22,0F22,0A22,0L22,0Y22
C     WITH 852**************************
      INTEGER A,FMIN,AMIN,Y1,Y2,Y3,Y4,B
      COMMON A(350,17),Y1(350),Y2(350),Y3(350),Y4(350),B(100,13)
      WRITE(4,786)
786   FORMAT(' C21')
321   LIST=IALEA(161,349)
      JAM=4000
      CALL WAVE(LIST,JAM)
      LIST4=LIST/4
      INC=IALEA(1,13)
      IJ=IALEA(2,6)
      WRITE(4,)LIST,INC,IJ
5555  DO 535 IZ=1,100,IJ
      L=B(IZ,1NC)+2
      IV=IALEA(100,200)
2233  LOW=5
      JWAF=IALEA(1,20)
      IF(JWAF.EQ.9)LOW=1
      JW1=IALEA(LOW,17)
      JW=IALEA(LOW,17)
      NENV=IALEA(5,15)
      LL=L
      NPER=IALEA(1,1)
      MFLAT=IALEA(1,20)
      IF(MFLAT.EQ.9)NPER=IALEA(1,3)
      MPER=NPER
      KDIFF=IALEA(1,10)
      IF(MFLAT.EQ.9.AND.KDIFF.LT.4)MPER=IALEA(1,3)
      JTOT=LIST
      JOVE=1
      IJOO=IALEA(1,20)
      IF(IJOO.EQ.3)JOVE=IALEA(2,4)
      JENV=(LIST+1)*NPER*JOVE/L
      KENV=(LIST+1)*MPER*JOVE/LL
      AMIN=IALEA(1,LIST4)
      LIN=AMIN
      FMIN=AMIN
      JOUT=IALEA(1,14)
      IF(JOUT.GT.10)JOUT=1
      JJJ=IALEA(1,40)
      IF(JJJ.EQ.9)JOUT=11
      IF(JJJ.NE.9)GO TO 111
      DO 43 I=1,LIST
43    Y1(I)=A(1,NENV)
      GO TO 3333
111   DO 11 I=1,LIST
11    Y1(I)=A(I,NENV)/IV+1
3333  CONTINUE
543   GO TO (222,222,222,444,444,555,555,666,777,777,333),JOUT
222   CALL OUT6(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
      GO TO 999
333   CALL OUT7(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
      GO TO 999
444   L=IALEA(1,9)
      CALL OUT8(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
```

```
     1KENV,Y1,FMIN,JOVE)
     GO TO 999
555  CALL OUT9(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,AMIN,JOVE)
     GO TO 999
666  CALL OUT10(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
     GO TO 999
777  CALL OUT11(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,LIN,JOVE)
     GO TO 999
999  CONTINUE
535  CONTINUE
     RETURN
     END
```

```
      SUBROUTINE C11(LIST)
C     C11
C     F3*********************
C     FVIV2*****WITH 852*******
C     WITH WAV2,0IN3,0FM3,0AM3,0LAY3,0IN33
      INTEGER FMIN,FMIM,AMIN,AMIM
      INTEGER HIGH
      INTEGER A,Y1,Y2,B
      COMMON A(400,17),Y1(400),Y2(400),B(100,13)
      WRITE(4,786)
786   FORMAT(' C11')
321   LIST=IALEA(100,300)
      JAM=4000
      CALL WAVE(LIST,JAM)
      LIST2=LIST/2
      LIST4=LIST/4
      LIST5=LIST/5
      INC=IALEA(1,13)
      INC1=IALEA(1,13)
      IJ=IALEA(7,13)
      IPER=IALEA(1,4)
      IPER1=IALEA(1,4)
      GO TO(1,1,1,2),IPER
1     IGH=100
      GO TO 555
2     IGH=500
555   GO TO(13,13,13,23),IPER1
13    IGH1=100
      GO TO 5553
23    IGH1=500
5553  WRITE(4,)LIST,INC,INC1,IJ
5555  DO 535 IZ=1,100,IJ
      JW=IALEA(5,17)
      JW1=IALEA(5,17)
6666  NENV=IALEA(5,15)
      NENV1=IALEA(5,15)
      IV=IALEA(100,200)
      IV1=IALEA(100,200)
      JJJ=IALEA(1,1)
      IF(JJJ.NE.9)GO TO 111
      IV=1
      IV1=1
111   DO 11 I=1,LIST
      Y1(I)=A(I,NENV)/IV+1
11    Y2(I)=A(I,NENV1)/IV1+1
      L=B(IZ,INC)+1
      LL=B(IZ,INC1)+1
      HIGH=IALEA(1,10)
673   NPER=L*L
      MPER=LL*LL
      IF(L.GT.11)NPER=L*(L-LH)
      IF(LL.GT.11)MPER=LL*(LL-LH)
      IF(L.LT.11)NPER=L*(L*LH)
      IF(LL.LT.11)MPER=LL*(LL*LH)
      IF(NPER.LT.L)NPER=L
      IF(MPER.LT.LL)MPER=LL
      JENV=NPER/L
      KENV=MPER/LL
      JSWI=IALEA(1,13)
      IF(JSWI.GT.10)JSWI=1
```

```
      IF(JJJ.EQ.9)JSWI=12
      IF(JJJ.EQ.3)JSWI=11
      GO TO (222,222,222,222,333,333,333,444,444,444,666,777),JSWI
222   CALL OUT12(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2)
      GO TO 999
333   FMIN=L+1
      FMIM=LL-1
      CALL OUT13(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2,FMIN,FMIN)
      GO TO 999
444   AMIN=L+1
      AMIM=LL-1
      CALL OUT14(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2,AMIN,AMIN)
      GO TO 999
666   CALL OUT15(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2)
      GO TO 999
777   CALL OUT16(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2)
      GO TO 999
999   CONTINUE
535   CONTINUE
      LH=LH+5
      GO TO 321
      RETURN
      END
```

```
      SUBROUTINE C30(LIST)
C     C30
C     F3*******************
C     FVIV2*****WITH B52*******
C     WITH WAV2,0IN3,0FM3,0AM3,0LAY3,0IN33
      INTEGER FMIN,FMIM,AMIN,AMIM
      INTEGER HIGH
      INTEGER A,Y1,Y2,Y3,Y4,B
      COMMON A(350,17),Y1(350),Y2(350),Y3(350),Y4(350),B(100,13)
      WRITE(4,786)
786   FORMAT(' C30')
321   LIST=IALEA(100,300)
      JAM=4000
      CALL WAVE(LIST,JAM)
      LIST2=LIST/2
      LIST4=LIST/4
      LIST5=LIST/5
      INC=IALEA(1,13)
      INC1=IALEA(1,13)
      IJ=IALEA(1,5)
      IPER=IALEA(1,4)
      IPER1=IALEA(1,4)
      GO TO(1,1,1,2),IPER
1     IGH=100
      GO TO 555
2     IGH=400
555   GO TO(13,13,13,23),IPER1
13    IGH1=100
      GO TO 5553
23    IGH1=400
5553  WRITE(4,)LIST,INC,INC1,IJ
      NENV2=IALEA(1,4)
      NENV3=IALEA(1,4)
      DO 131 I=1,LIST
      Y3(1)=A(1,NENV2)/100+1
131   Y4(I)=A(I,NENV3)/100+1
      JCH00=IALEA(1,100)
      JFLG=2
      IF(JCH00.LT.51)JFLG=1
      GO TO (15,25),JFLG
15    JJJ=1
      JSWI=6
      JB=5
      JT=17
      JT1=15
      GO TO 3
25    JJJ=9
      JSWI=6
      JB=1
      JT=4
      JT1=4
3     JCNT=0
      JSEC=100/IJ
      JOU=JSEC/7
      JOU7=0
5555  DO 535 IZ=1,100,IJ
      JOU7=JOU7+1
      IF(JOU7.LE.JOU)GO TO 67
      JOU7=1
      JCNT=JCNT+1
```

```
      GO TO (17,27),JFLG
17    GO TO (67,65,64,63,61,62,62,66,66),JCNT
62    JJJ=9
      JSWI=6
      GO TO 67
63    JSWI=4
      GO TO 67
64    JSWI=3
      GO TO 67
65    JSWI=2
      GO TO 67
66    JB=1
      JT=4
      JT1=4
      GO TO 67
61    JSWI=5
67    GO TO 37
27    GO TO (52,51,53,54,55,56,56,56,56,56),JCNT
52    JB=5
      JT=17
      JT1=15
      GO TO 57
53    JSWI=4
      GO TO 57
54    JSWI=3
      GO TO 57
55    JSWI=2
      GO TO 57
56    JSWI=1
      GO TO 57
51    JSWI=5
      JJJ=1
      GO TO 57
57    CONTINUE
37    JW=IALEA(JB,JT)
      JW1=IALEA(JB,JT)
6666  NENV=IALEA(JB,JT1)
      NENV1=IALEA(JB,JT1)
      IV=IALEA(100,200)
      IV1=IALEA(100,200)
      IF(JJJ.NE.9)GO TO 111
      IV=1
      IV1=1
111   DO 11 I=1,LIST
      Y1(I)=A(I,NENV)/IV+1
11    Y2(I)=A(I,NENV1)/IV1+1
      L=B(IZ,INC)+3
      LL=B(IZ,INC1)+3
      HIGH=IALEA(1,10)
673   NPER=IALEA(25,IGH)
      MPER=IALEA(25,IGH1)
      JENV=NPER/L
      KENV=MPER/LL
      GO TO (222,333,444,666,888,777),JSWI
222   CALL OUT12(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
      1JENV,KENV,Y1,Y2)
      GO TO 999
333   FMIN=IALEA(1,LIST4)
      FMIM=IALEA(1,LIST4)
      CALL OUT13(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
```

```
     1JENV,KENV,Y1,Y2,FMIN,FMIN)
     GO TO 999
444  AMIN=IALEA(1,LIST4)
     AMIM=IALEA(1,LIST4)
     CALL OUT14(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2,AMIN,AMIN)
     GO TO 999
666  CALL OUT15(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2)
     GO TO 999
777  CALL OUT16(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2)
     GO TO 999
888  CALL OUT151(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2,Y3,Y4)
     GO TO 999
999  CONTINUE
535  CONTINUE
     RETURN
     END
```

```
      SUBROUTINE C40(JSEED,LIST)
C     C40
C     F3********************
C     FVLV1:::  CALLED BY FVLV*****
C     WITH WAV2,0IN3,0FM3,0AM3,0LAY3,0IN33,0LA45
      INTEGER FMIN,FMIM,AMIN,AMIM
      INTEGER HIGH
      INTEGER A,Y1,Y2,Y3,Y4,B
      COMMON A(350,17),Y1(350),Y2(350),Y3(350),Y4(350),B(100,13)
      JCH00=IALEA(1,100)
      IF(JCH00.LT.51)JSWI=7
      IF(JCH00.GT.50)JSWI=0
      WRITE(4,786)
786   FORMAT(' C40')
321   LIST=IALEA(100,349)
      JAM=4000
      CALL WAVE(LIST,JAM)
      JSEED=JSEED+1
      LIST2=LIST/2
      JAMP=IALEA(4,10)
      LIST4=LIST/4
      LIST5=LIST/5
      IPER=IALEA(1,5)
      IPER1=IALEA(1,5)
      GO TO(1,1,1,2,3),IPER
1     IGH=100
      GO TO 555
2     IGH=400
      GO TO 555
3     IGH=800
555   GO TO(13,13,13,23,33),IPER1
13    IGH1=100
      GO TO 5553
23    IGH1=400
      GO TO 5553
33    IGH1=800
5553  WRITE(4,)LIST,JAMP
      NENV2=IALEA(1,4)
      NENV3=IALEA(1,4)
      DO 131 I=1,LIST
      Y3(1)=A(1,NENV2)/100+1
131   Y4(I)=A(I,NENV3)/100+1
3212  IF(JCH00.LT.51)JSWI=JSWI-1
      IF(JCH00.GT.50)JSWI=JSWI+1
      IF(JSWI.GT.6)GO TO 3456
      IF(JSWI.LT.1)GO TO 3456
      WRITE(4,)JSWI
      CALL RANDOM(JSEED,X1)
5555  DO 535 IZ=1,JAMP
      JW=IALEA(5,17)
      JW1=IALEA(5,17)
6666  NENV=IALEA(5,15)
      NENV1=IALEA(5,15)
      IV=IALEA(100,200)
      IV1=IALEA(100,200)
      IF(JSWI.LT.6)GO TO 111
      IV=1
      IV1=1
111   DO 11 I=1,LIST
      Y1(I)=A(I,NENV)/IV+1
```

```
11      Y2(I)=A(I,NENV1)/IV1+1
        L=IALEA(6,LIST2)
        LL=IALEA(6,LIST2)
        HIGH=IALEA(1,10)
673     NPER=IALEA(25,IGH)
        MPER=IALEA(25,IGH1)
        JENV=NPER/L
        KENV=MPER/LL
        FMIN=IALEA(6,LIST4)
        FMIM=IALEA(6,LIST4)
        AMIN=FMIN
        AMIM=FMIM
        GO TO (222,333,444,666,888,777),JSWI
222     CALL OUT12(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
        1JENV,KENV,Y1,Y2)
        GO TO 999
333     CALL OUT13(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
        1JENV,KENV,Y1,Y2,FMIN,FMIN)
        GO TO 999
444     CALL OUT14(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
        1JENV,KENV,Y1,Y2,AMIN,AMIN)
        GO TO 999
666     CALL OUT15(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
        1JENV,KENV,Y1,Y2)
        GO TO 999
777     CALL OUT16(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
        1JENV,KENV,Y1,Y2)
        GO TO 999
888     CALL OUT151(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
        1JENV,KENV,Y1,Y2,Y3,Y4)
        GO TO 999
999     CONTINUE
535     CONTINUE
        GO TO 3212
3456    CONTINUE
        RETURN
        END
```

```
      SUBROUTINE C21VL(LIST)
C     FXIX2 WITH WAV2 ** 0W22,0WW22,0F22,0A22,0L22,0Y22
      INTEGER A,FMIN,AMIN,Y1,Y2,Y3,Y4
      COMMON A(350,17),Y1(350),Y2(350),Y3(350),Y4(350)
      JCH00=IALEA(1,100)
      IF(JCH00.LT.51)JOUT=0
      IF(JCH00.GT.50)JOUT=8
      WRITE(4,786)
786   FORMAT(' C21VL')
321   LIST=IALEA(100,333)
      JAM=4000
      CALL WAVE(LIST,JAM)
      JSEED=JSEED+1
      JAMP=IALEA(2,5)
      WRITE(4,)LIST,JAMP
      LIST4=LIST/4
      NENV1=IALEA(1,4)
      DO 131 I=1,LIST
131   Y2(1)=A(I,NENV1)/100+1
3212  IF(JCH00.LT.51)JOUT=JOUT+1
      IF(JCH00.GT.50)JOUT=JOUT-1
      IF(JOUT.GT.7)GO TO 123
      IF(JOUT.LT.1)GO TO 123
      WRITE(4,)JOUT
      CALL RANDOM(JSEED,X1)
      DO 535 IZ=1,JAMP
      IV=IALEA(100,200)
2233  JW1=IALEA(5,17)
      JW=IALEA(5,17)
      NENV=IALEA(5,15)
      L=IALEA(2,LIST4)
      LL=L
      NPER=IALEA(1,1)
      MFLAT=IALEA(1,20)
      IF(MFLAT.EQ.9)NPER=IALEA(1,3)
      MPER=NPER
      KDIFF=IALEA(1,10)
      IF(MFLAT.EQ.9.AND.KDIFF.LT.4)MPER=IALEA(1,3)
      JTOT=LIST
      JOVE=1
      IJ00=IALEA(1,20)
      IF(IJ00.EQ.3)JOVE=IALEA(2,4)
      JENV=(LIST+1)*NPER*JOVE/L
      KENV=(LIST+1)*MPER*JOVE/LL
      AMIN=IALEA(1,LIST4)
      LIN=AMIN
      FMIN=AMIN
      IF(JOUT.NE.7)GO TO 111
      DO 43 I=1,LIST
43    Y1(1)=A(I,NENV)
      GO TO 3333
111   DO 11 I=1,LIST
11    Y1(I)=A(I,NENV)/IV+1
3333  CONTINUE
543   GO TO (222,777,555,444,666,888,333),JOUT
222   CALL OUT6(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
      GO TO 999
333   CALL OUT7(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
```

```
      GO TO 999
444   CALL OUT8(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,FMIN,JOVE)
      GO TO 999
555   CALL OUT9(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,AMIN,JOVE)
      GO TO 999
666   CALL OUT10(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
      GO TO 999
777   CALL OUT11(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,LIN,JOVE)
      GO TO 999
888   CALL OUT101(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE,Y2)
999   CONTINUE
535   CONTINUE
      GO TO 3212
123   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE C21FH(LIST)
C     FXIX2 WITH WAV2 ** 0W22,0WW22,0F22,0A22,0L22,0Y22
C     WITH B52*************************
      INTEGER A,FMIN,AMIN,Y1,Y2,Y3,Y4,B
      COMMON A(350,17),Y1(350),Y2(350),Y3(350),Y4(350),B(100,13)
      WRITE(4,786)
786   FORMAT(' C21FH')
321   LIST=IALEA(161,319)
      JAM=4000
      CALL WAVE(LIST,JAM)
      LIST4=LIST/4
      INC=IALEA(1,13)
      IJ=IALEA(2,6)
      WRITE(4,)LIST,INC,IJ
      NENV1=IALEA(1,4)
      DO 131 I=1,LIST
131   Y2(1)=A(I,NENV1)/75+1
      JCH00=IALEA(1,100)
      JFLG=2
      IF(JCH00.LT.51)JFLG=1
      GO TO (1,2),JFLG
1     JOUT=7
      JJJ=9
      JB=1
      JT=4
      JT1=4
      GO TO 3
2     JOUT=1
      JJJ=1
      JB=5
      JT=17
      JT1=15
3     JCNT=0
      JSEC=100/IJ
      JOU=JSEC/8
      JOU7=0
5555  DO 535 IZ=1,100,IJ
      JOU7=JOU7+1
      IF(JOU7.LE.JOU)GO TO 67
      JOU7=1
      JCNT=JCNT+1
      GO TO (17,27),JFLG
17    GO TO (62,61,63,64,65,66,66,60,60,60,60),JCNT
62    JB=5
      JT=17
      JT1=15
      GO TO 67
63    JOUT=5
      GO TO 67
64    JOUT=4
      GO TO 67
65    JOUT=3
      GO TO 67
66    JOUT=2
      GO TO 67
60    JOUT=1
      GO TO 67
61    JOUT=6
      JJJ=1
      GO TO 67
```

```
67      GO TO 37
27      GO TO (56,55,54,53,51,50,50,52,52,52),JCNT
52      JB=1
        JT=4
        JT1=4
        GO TO 57
53      JOUT=5
        GO TO 57
54      JOUT=4
        GO TO 57
55      JOUT=3
        GO TO 57
56      JOUT=2
        GO TO 57
50      JOUT=7
        JJJ=9
        GO TO 57
51      JOUT=6
        GO TO 57
57      CONTINUE
37      L=B(IZ,INC)+2
        IV=IALEA(100,150)
2233    JW1=IALEA(JB,JT)
        JW=IALEA(JB,JT)
        NENV=IALEA(JB,JT1)
        LL=L
        NPER=IALEA(1,1)
        MFLAT=IALEA(1,20)
        IF(MFLAT.EQ.9)NPER=IALEA(1,3)
        MPER=NPER
        KDIFF=IALEA(1,10)
        IF(MFLAT.EQ.9.AND.KDIFF.LT.4)MPER=IALEA(1,3)
        JTOT=LIST
        JOVE=1
        IJOO=IALEA(1,20)
        IF(IJOO.EQ.3)JOVE=IALEA(2,4)
        JENV=(LIST+1)*NPER*JOVE/L
        KENV=(LIST+1)*MPER*JOVE/LL
        AMIN=IALEA(1,LIST4)
        LIN=AMIN
        FMIN=AMIN
        IF(JJJ.NE.9)GO TO 111
        DO 43 I=1,LIST
43      Y1(I)=A(I,NENV)/10
        GO TO 3333
111     DO 11 I=1,LIST
11      Y1(I)=A(I,NENV)/IV+1
3333    CONTINUE
543     GO TO (222,444,555,777,666,888,333),JOUT
222     CALL OUT6(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,JOVE)
        GO TO 999
333     CALL OUT7(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,JOVE)
        GO TO 999
444     CALL OUT8(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,FMIN,JOVE)
        GO TO 999
555     CALL OUT9(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,AMIN,JOVE)
```

```
      GO TO 999
666   CALL OUT10(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
      GO TO 999
777   CALL OUT11(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,LIN,JOVE)
      GO TO 999
888   CALL OUT101(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE,Y2)
999   CONTINUE
535   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE C50(LIST)
C     C50
C     F3********************
C     FVIV2*****WITH 852*******
C     WITH WAV2,0IN3,0FM3,0AM3,0LAY3,0IN33
      INTEGER FMIN,FMIM,AMIN,AMIM
      INTEGER HIGH
      INTEGER A,Y1,Y2,Y3,Y4,B
      COMMON A(350,17),Y1(350),Y2(350),Y3(350),Y4(350),B(100,13)
      WRITE(4,786)
786   FORMAT(' C50')
      JAMP=IALEA(6,12)
      LIST2=LIST/2
      LIST4=LIST/4
      LIST5=LIST/5
5432  IPER=IALEA(1,4)
      IPER1=IALEA(1,4)
      GO TO(1,1,1,2),IPER
1     IGH=150
      GO TO 555
2     IGH=700
555   GO TO(13,13,13,23),IPER1
13    IGH1=150
      GO TO 5553
23    IGH1=700
5553  JW=IALEA(5,17)
      JW1=IALEA(5,17)
6666  NENV=IALEA(5,15)
      NENV1=IALEA(5,15)
      NENV2=IALEA(1,5)
      IF(NENV2.EQ.5)NENV2=16
      NENV3=IALEA(1,5)
      IF(NENV3.EQ.5)NENV3=16
      IV=100
      IV1=100
      JJJ=1
      IF(JJJ.NE.9)GO TO 111
      IV=1
111   DO 11 I=1,LIST
      Y1(I)=A(I,NENV)/IV+1
      Y3(I)=A(I,NENV2)/IV1+1
      Y4(I)=A(I,NENV3)/IV1+1
11    Y2(I)=A(I,NENV1)/IV+1
      L=IALEA(9,LIST2)
      LL=IALEA(9,LIST2)
      HIGH=IALEA(1,10)
673   NPER=IALEA(25,IGH)
      MPER=IALEA(25,IGH1)
      JENV=NPER/L
      KENV=MPER/LL
666   CALL OUT151(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2,Y3,Y4)
      GO TO 999
999   JAMP=JAMP-1
      IF(JAMP.GT.0)GO TO 5432
      RETURN
      END
```

```
C       CF4F
C       F4**********************
C       WITN 0IN4,0IN44,0IN45,0FM4,0AM4,0LAY4
        SUBROUTINE CF4F(LIST)
        INTEGER FMIN,FMIN1,FMIN2,FMIN3,AMIN,AMIN1,AMIN2,AMIN3
        INTEGER A,Y1,Y2,Y3,Y4
        COMMON A(350,17),Y1(350),Y2(350),Y3(350),Y4(350)
        LIST4=LIST/4
        LIST5=LIST/5
        JAMP=IALEA(2,3)
        WRITE(4,786)
786     FORMAT(' CF4F')
        WRITE(4,)JAMP
        DO 535 IZ=1,JAMP
        LLO=IALEA(1,3)
        LLLO=IALEA(1,3)
        LLLLO=IALEA(1,3)
        IF(LIST.LT.200)IPER=5
        IF(LIST.GT.199.AND.LIST.LT.300)IPER=4
        IF(LIST.GT.299)IPER=3
        GO TO (1,2,3,4,5),IPER
1       IGH=50
        GO TO 555
2       IGH=200
        GO TO 555
3       IGH=1500
        LO=1400
        GO TO 555
4       IGH=1900
        LO=1800
        GO TO 555
5       IGH=2500
        LO=2400
555     IV=IALEA(300,600)
        IV1=IALEA(300,600)
        IV2=IALEA(300,600)
        IV3=IALEA(300,600)
        JSWQ=IALEA(1,10)
        IF(JSWQ.GT.2)GO TO 5555
        JW=IALEA(1,17)
        JW1=IALEA(1,17)
        JW2=IALEA(1,17)
        JW3=IALEA(1,17)
        GO TO 666
5555    JW=IALEA(5,17)
        JW1=IALEA(5,17)
        JW2=IALEA(5,17)
        JW3=IALEA(5,17)
666     NENV=IALEA(5,15)
        NENV1=IALEA(5,15)
        NENV2=IALEA(5,15)
        NENV3=IALEA(5,15)
        JJJ=IALEA(1,30)
        IF(JJJ.NE.1)GO TO 111
        IV=1
        IV1=IV
        IV2=IV
        IV3=IV
111     DO 11 I=1,LIST
        Y1(I)=A(I,NENV)/IV+1
```

```
      Y2(1)=A(I,NENV1)/IV1+1
      Y3(I)=A(I,NENV2)/IV2+1
11    Y4(I)=A(I,NENV3)/IV3+1
888   LISTI=LIST4
      JSWI=IALEA(1,8)
      IF(JSWI.GT.6.AND.JJJ.LT.2)LIST1=LIST1+LIST1-41
      L=IALEA(4,LISTI)
      LL=L+LLO
      LLL=LL+LLLO
      LLLL=LLL+LLLLO
      NPER=IALEA(LO,IGH)
      MPER=IALEA(LO,IGH)
      JPER=IALEA(LO,IGH)
      KPER=IALEA(LO,IGH)
      JENV=NPER/L
      KENV=MPER/LL
      LENV=JPER/LLL
      MENV=KPER/LLLL
      IF(JJJ.EQ.1)JSWI=10
      IF(JJJ.EQ.2)JSWI=9
      GO TO (222,222,1010,1010,444,444,333,333,1111,777),JSWI
222   CALL OUT17(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
      GO TO 999
777   CALL OUT18(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
      GO TO 999
1010  CALL OUT19(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
      GO TO 999
333   FMIN=IALEA(1,LIST4)
      FMIN1=IALEA(1,LIST4)
      FMIN2=IALEA(1,LIST4)
      FMIN3=IALEA(1,LIST4)
      CALL OUT20(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4,FMIN,FMIN1,FMIN2,FMIN3)
      GO TO 999
444   AMIN=IALEA(8,LIST4)
      AMIN1=IALEA(8,LIST4)
      AMIN2=IALEA(8,LIST4)
      AMIN3=IALEA(8,LIST4)
      CALL OUT21(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4,AMIN,AMIN1,AMIN2,AMIN3)
      GO TO 999
1111  CALL OUT22(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
999   CONTINUE
535   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE SIL
      MAX=IALEA(300,1100)
      WRITE(4,)MAX
      DO 11 I=1,MAX
      WRITE(4,786)I
786   FORMAT('+',I5)
11    CONTINUE
      RETURN
      END
```

```
C       F44************************
C       WITH SHORT+++++++
C       WITH OIN4,OIN44,OIN45,OFM4,OAM4,OLAY4
        INTEGER FMIN,FMIN1,FMIN2,FMIN3,AMIN,AMIN1,AMIN2,AMIN3
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        COMMON A(500,17),Y1(500),Y2(500),Y3(500),Y4(500),
        1S(500),Z(500)
        WRITE(4,786)
786     FORMAT(' SEED VALUE?')
        READ(4,)JSEED
        CALL RANDOM(JSEED,X1)
        DO 1987 IP=1,1000
        WRITE(4,)IP
1987    CONTINUE
321     LIST=IALEA(100,500)
        JAM=IALEA(4000,4000)
        CALL WAVE(LIST,JAM)
        LIST4=LIST/4
        LIST5=LIST/5
555     IV=IALEA(100,200)
        IV1=IALEA(100,200)
        IV2=IALEA(100,200)
        IV3=IALEA(100,200)
        JSWQ=IALEA(1,10)
        IF(JSWQ.GT.2)GO TO 5555
        JW=IALEA(1,17)
        JW1=IALEA(1,17)
        JW2=IALEA(1,17)
        JW3=IALEA(1,17)
        GO TO 666
5555    JW=IALEA(5,17)
        JW1=IALEA(5,17)
        JW2=IALEA(5,17)
        JW3=IALEA(5,17)
666     NENV=IALEA(5,15)
        NENV1=IALEA(5,15)
        NENV2=IALEA(5,15)
        NENV3=IALEA(5,15)
        JJJ=IALEA(1,20)
        IF(JJJ.NE.9)GO TO 111
        IV=1
        IV1=IV
        IV2=IV
        IV3=IV
111     DO 11 I=1,LIST
        Y1(I)=A(I,NENV)/IV+1
        Y2(I)=A(I,NENV1)/IV1+1
        Y3(I)=A(I,NENV2)/IV2+1
11      Y4(I)=A(I,NENV3)/IV3+1
888     LIST1=LIST4
        JSWI=IALEA(1,9)
        IF(JSWI.GT.7.AND.JJJ.NE.9)LIST1=LIST1+LIST1-41
        L=IALEA(4,LIST1)
        LL=IALEA(4,LIST1)
        LLL=IALEA(4,LIST1)
        LLLL=IALEA(4,LIST1)
        CALL SHORT(JSET,LO,IGH,JWAIT,IK)
        NPER=IALEA(LO,IGH)
        MPER=IALEA(LO,IGH)
        JPER=IALEA(LO,IGH)
```

```
      KPER=IALEA(LO,IGH)
      JENV=NPER/L
      KENV=MPER/LL
      LENV=JPER/LLL
      MENV=KPER/LLLL
      IF(JJJ.EQ.9)JSWI=10
      IF(IK.GT.48)GO TO 999
      GO TO (222,222,1111,1010,1010,444,444,333,333,777),JSWI
222   CALL OUT17(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
      GO TO 999
777   CALL OUT18(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
      GO TO 999
1010  CALL OUT19(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
      GO TO 999
333   FMIN=IALEA(1,LIST4)
      FMIN1=IALEA(1,LIST4)
      FMIN2=IALEA(1,LIST4)
      FMIN3=IALEA(1,LIST4)
      CALL OUT20(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4,FMIN,FMIN1,FMIN2,FMIN3)
      GO TO 999
444   AMIN=IALEA(8,LIST4)
      AMIN1=IALEA(8,LIST4)
      AMIN2=IALEA(8,LIST4)
      AMIN3=IALEA(8,LIST4)
      CALL OUT21(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4,AMIN,AMIN1,AMIN2,AMIN3)
      GO TO 999
1111  CALL OUT22(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
999   DO 975 IJ=1,JWAIT
      LOWW=LO/2
      CALL LOOP(LOWW)
975   CONTINUE
      WRITE(4,)JWAIT,IK
      IF(JWAIT.GT.10000)GO TO 531
      GO TO 555
531   CALL F444
      CONTINUE
      STOP
      END
```

```
C       F444************************
C       WITH SHORT********
C       WITN OIN4,OIN44,OIN45,OFM4,OAM4,OLAY4
        SUBROUTINE F444(LIST)
        INTEGER FMIN,FMIN1,FMIN2,FMIN3,AMIN,AMIN1,AMIN2,AMIN3
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        COMMON A(500,17),Y1(500),Y2(500),Y3(500),Y4(500),
        1S(500),Z(500)
        LIST4=LIST/4
        LIST5=LIST/5
        JWAIT=100000
555     IV=IALEA(100,200)
        IV1=IALEA(100,200)
        IV2=IALEA(100,200)
        IV3=IALEA(100,200)
        JSWQ=9
        IF(JSWQ.GT.2)GO TO 5555
        JW=IALEA(1,17)
        JW1=IALEA(1,17)
        JW2=IALEA(1,17)
        JW3=IALEA(1,17)
        GO TO 666
5555    JW=IALEA(5,17)
        JW1=IALEA(5,17)
        JW2=IALEA(5,17)
        JW3=IALEA(5,17)
666     NENV=IALEA(5,15)
        NENV1=IALEA(5,15)
        NENV2=IALEA(5,15)
        NENV3=IALEA(5,15)
        JJJ=9
        IF(JJJ.NE.9)GO TO 111
        IV=1
        IV1=IV
        IV2=IV
        IV3=IV
111     DO 11 I=1,LIST
        Y1(I)=A(I,NENV)/IV+1
        Y2(I)=A(I,NENV1)/IV1+1
        Y3(1)=A(I,NENV2)/IV2+1
11      Y4(I)=A(I,NENV3)/IV3+1
888     LIST1=LIST4
        JSWI=IALEA(1,9)
        IF(JSWI.GT.7.AND.JJJ.NE.9)LIST1=LIST1+LIST1-41
140     L=IALEA(4,LISTI)
        LL=IALEA(4,LIST1)
        LLL=IALEA(4,LISTI)
        LLLL=IALEA(4,LIST1)
        NPER=IALEA(15,20)
        MPER=IALEA(15,20)
        JPER=IALEA(15,20)
        KPER=IALEA(15,20)
        JENV=NPER/L
        KENV=MPER/LL
        LENV=JPER/LLL
        MENV=KPER/LLLL
        IF(JJJ.EQ.9)JSWI=10
        GO TO (222,222,1111,1010,1010,444,444,333,333,777),JSWI
222     CALL OUT17(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
        1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
```

```
     1LENV,MENV,Y3,Y4)
     GO TO 999
777  CALL OUT18(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
     GO TO 999
1010 CALL OUT19(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
     GO TO 999
333  FMIN=IALEA(1,LIST4)
     FMIN1=IALEA(1,LIST4)
     FMIN2=IALEA(1,LIST4)
     FMIN3=IALEA(1,LIST4)
     CALL OUT20(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4,FMIN,FMIN1,FMIN2,FMIN3)
     GO TO 999
444  AMIN=IALEA(8,LIST4)
     AMIN1=IALEA(8,LIST4)
     AMIN2=IALEA(8,LIST4)
     AMIN3=IALEA(8,LIST4)
     CALL OUT21(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4,AMIN,AMIN1,AMIN2,AMIN3)
     GO TO 999
1111 CALL OUT22(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
999  DO 975 I=1,JWAIT
975  CONTINUE
     JWAIT=JWAIT-6000
     IF(JWAIT.LT.1)JWAIT=1
     IF(JWAIT.EQ.1)JMANY=JMANY+1
     IF(JMANY.GT.2.AND.JMANY.LT.30)GO TO 140
     IF(JMANY.GT.29)GO TO 531
     GO TO 555
531  CALL FTOT22
     CONTINUE
     CALL FBUBB
     CONTINUE
     RETURN
     END
```

```
C       SHORT********
        SUBROUTINE SHORT (JSET,LO,IGH,JWAIT,IK)
        IF(JSET.EQ.1)GO TO 1
        IGH=3500
        LO=3400
        JWAIT=1
        IK=70
        JCNT=0
        NUM=1
        JSET=1
1       IF(IK.LT.1)GO TO 123
        II=IK**1.9+1
        J=II/25
        IK=IK-1
        LO=LO-J
        IGH=IGH-J
        GO TO 456
123     IF(JCNT.EQ.1)GO TO 234
        LO=LO-5
        IGH=IGH-5
        IF(IGH.LE.50)JCNT=1
        IF(LO.LT.25)LO=25
        GO TO 456
234     IF(LO.GT.25)JWAIT=JWAIT+1000
        IGH=IGH-NUM
        LO=LO-NUM
        IF(LO.LT.1)LO=1
        IF(IGH.LT.10)NUM=-NUM
        GO TO 456
456     CONTINUE
        RETURN
        END
```

```
      SUBROUTINE FTOT22
C     FTOT22 WITH WAV2 ** 0W22,0WW22,0F22,0A22,0L22,0Y22
      INTEGER A,FMIN,AMIN,Y1
      INTEGER HIGH
      COMMON A(500,22),Y1(500)
      CALL RANDOM(123,X1)
321   LIST=IALEA(100,500)
      JAM=4000
      IHUN=1
      LIST2=LIST/2
      LIST5=LIST/5
      LISTF=LIST5
      LIST4=LIST/4
      LOW=1
5555  CALL NPCH(LO,LI,LOP,LIP,JSET,JJJ,IHUN)
      JW=IALEA(LO,LI)
      JW1=IALEA(LO,LI)
      NENV=IALEA(LOP,LIP)
      IV=IALEA(100,200)
      HIGH=IALEA(LOW,10)
      L=IALEA(1,LIST5)
      JAMP=JAMP+1
      IF(JAMP.GT.320)LIST5=LIST5-1
      IF(LIST5.LT.10)LOW=9
      IF(LIST5.LT.3)LIST5=2
      IF(JAMP.GT.400)GO TO 9090
      IF(HIGH.EQ.9)L=IALEA(45,LISTF)
      LL=L
      NPER=IALEA(1,1)
      MFLAT=IALEA(1,10)
      IF(MFLAT.EQ.9)NPER=IALEA(1,5)
      MPER=NPER
      KDIFF=IALEA(1,10)
      IF(MFLAT.EQ.9.AND.KDIFF.LT.4)MPER=IALEA(1,5)
      JTOT=LIST
      JOVE=1
      JLOO=IALEA(1,10)
      IF(JLOO.EQ.3)JOVE=IALEA(2,4)
      JENV=(LIST+1)*NPER*JOVE/L
      KENV=(LIST+1)*MPER*JOVE/LL
      AMIN=IALEA(1,LIST4)
      LIN=AMIN
      FMIN=AMIN
      IF(JJJ.NE.9)GO TO 111
      DO 43 I=1,LIST
43    Y1(I)=A(I,NENV)/IHUN+1
      GO TO 333
111   DO 11 I=1,LIST
11    Y1(I)=A(I,NENV)/IV+1
      JOUT=IALEA(1,10)
      IF(LIST5.LT.20)JOUT=1
      GO TO (222,222,222,444,444,555,555,666,777,777),JOUT
222   CALL OUT6(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
      GO TO 999
333   CALL OUT7(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
      GO TO 999
444   L=IALEA(1,8)
      LL=L
```

```
      CALL OUT8(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,FMIN,JOVE)
      GO TO 999
555   CALL OUT9(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,AMIN,JOVE)
      GO TO 999
666   CALL OUT10(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
      GO TO 999
777   CALL OUT11(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,LIN,JOVE)
      GO TO 999
999   GO TO 5555
9090  CONTINUE
      RETURN
      END
```

```
C       F3*******************
C       FTAT22*****WITH NPCH*******
C       WITH WAV2,0IN3,0FM3,0AM3,0LAY3,0IN33
        INTEGER FMIN,FMIM,AMIN,AMIM
        INTEGER HIGH
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        COMMON A(500,17),Y1(500),Y2(500),Y3(500),Y4(500),
        1S(500),Z(500)
        WRITE(4,786)
786     FORMAT(' SEED VALUE?')
        READ(4,)JSEED
        CALL RANDOM (JSEED,X1)
        DO 1987 IP=1,2000
        WRITE(4,)IP
1987    CONTINUE
321     LIST=IALEA(100,400)
        JAM=4000
        CALL WAVE(LIST,JAM)
        LIST2=LIST/2
        LIST4=LIST/4
        LIST5=LIST/5
        LOW=1
5555    CALL NPCH(LO,LI,LOP,LIP,JSET,JJJ,IHUN)
        IPER=IALEA(1,4)
        GO TO (1,1,2,3,4,5),IPER
1       IGH=100
        GO TO 555
2       IGH=500
        GO TO 555
3       IGH=1000
        GO TO 555
4       IGH=1500
        GO TO 555
5       IGH=2500
555     CONTINUE
        JW=IALEA(LO,LI)
        JW1=IALEA(LO,LI)
6666    NENV=IALEA(LOP,LIP)
        NENV1=ALEA(LOP,LIP)
        IV=IALEA(100,200)
        IV1=IALEA(100,200)
        IF(JJJ.NE.9)GO TO 111
        IV=1
        IV1=1
111     DO 11 I=1,LIST
        Y1(I)=A(I,NENV)/IV+1
11      Y2(I)=A(I,NENV1)/IV1+1
888     JAMP=JAMP+1
        IF(JAMP.GT.400)LIST5=LIST5-1
        IF(LIST5.LT.10)LOW=9
        IF(LIST5.LT.5)LIST5=4
        IF(JAMP.GT.470)GO TO 9090
        L=IALEA(3,LIST5)
        LL=IALEA(3,LIST5)
        HIGH=IALEA(LOW,10)
        IF(JAMP.GT.400.AND.HIGH.NE.9)GO TO 673
        L=IALEA(LIST4,LIST2)
        LL=IALEA(LIST4,LIST2)
673     NPER=IALEA(25,IGH)
        MPER=IALEA(25,IGH)
```

```
      JENV=NPER/L
      KENV=MPER/LL
      JSWI=IALEA(1,10)
      IF(JJJ.EQ.9)JSWI=11
      IF(LIST5.LT.20)JSWI=1
      GO TO (222,222,222,333,333,333,444,444,444,666,777),JSWI
222   CALL OUT12(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2)
      GO TO 999
333   FMIN=IALEA(1,LIST4)
      FMIM=IALEA(1,LIST4)
      CALL OUT13(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2,FMIN,FMIN)
      GO TO 999
444   AMIN=IALEA(1,LIST4)
      AMIM=IALEA(1,LIST4)
      CALL OUT14(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2,AMIN,AMIN)
      GO TO 999
666   CALL OUT15(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2)
      GO TO 999
777   CALL OUT16(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2)
      GO TO 999
999   GO TO 5555
      CONTINUE
9090  CALL FBUBA
      CONTINUE
      STOP
      END
```

```
      SUBROUTINE NPCH (LO,LI,LOP,LIP,JSET,JJJ,IHUN)
      JTOT=JTOT+1
      IF(JTOT.GT.75)GO TO 123
      JJJ=9
      IF(JTOT.GT.40)JJJ=IALEA(5,10)
      IHUN=IHUN+1
      LO=1
      LI=17
      LOP=1
      LIP=17
      GO TO 333
123   IF(JSET.EQ.1)GO TO 321
      JCNT=0
      LO=1
      LI=1
      JCNT1=-1
      LOP=1
      LIP=1
      JSET=1
321   IF(JTOT.LT.270)GO TO 222
      JJJ=1
      LO=5
      LOP=5
      GO TO 333
222   JCNT=JCNT+1
      IF(JCNT.LT.5)GO TO 333
      JJJ=IALEA(1,9)
      JCNT=0
      LI=LI+1
      IF(LI.GT.17)LI=17
      JCNT1=JCNT1+1
      IF(JCNT1.LT.2)GO TO 333
      JCNT1=0
      LIP=LIP+1
      IF(LIP.GT.15)LIP=15
333   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE FBUBB
C     FBUBB WITH WAV2 ** 0W22,0WW22,0F22,0A22,0L22,0Y22
      INTEGER A,FMIN,AMIN,Y1
      INTEGER INC(50)
      COMMON A(500,17),Y1(500)
      MCNT=0
      CALL RANDOM(1234,X1)
      LISTA=22
      LISTX=LISTA-1
      JSENZ=0
      JDUM=3
      DO 39 I=1,LISTA
39    INC(1)=IALEA(1,30)
      JVAL=23
321   LIST=350
      JAM=4000
      CALL WAVE(LIST,JAM)
      JAMP=LISTA
      LIST4=LIST/4
      LIST2=LIST/2
5555  DO 535 I=1,LISTX
      IF(INC(I+1).LT.INC(I))GO TO 535
      ISWAP=INC(I+1)
      INC(I+1)=INC(I)
      INC(I)=ISWAP
535   CONTINUE
      JVAL=JVAL-1
644   DO 64 II=1,LISTA
      IF(JDUM.NE.2)GO TO 3322
      JDUM=3
      GO TO 543
3322  CONTINUE
      L=INC(II)+JVAL
      IV=IALEA(100,200)
2233  LOW=5
      JWAF=IALEA(1,20)
      IF(JWAF.EQ.9)LOW=1
      JW1=IALEA(LOW,17)
      JW=IALEA(LOW,17)
      NENV=IALEA(8,15)
      LL=L
      NPER=IALEA(1,1)
      MFLAT=IALEA(1,20)
      IF(MFLAT.EQ.9)NPER=IALEA(1,3)
      MPER=NPER
      KDIFF=IALEA(1,10)
      IF(MFLAT.EQ.9.AND.KDIFF.LT.4)MPER=IALEA(1,3)
      JTOT=LIST
      JOVE=1
      IJOO=IALEA(1,20)
      IF(IJOO.EQ.3)JOVE=IALEA(2,4)
      JENV=(LIST+1)*NPER*JOVE/L
      KENV=(LIST+1)*MPER*JOVE/LL
      AMIN=IALEA(1,LIST4)
      LIN=AMIN
      FMIN=AMIN
      JOUT=IALEA(1,64)
      IF(JOUT.GT.11)JOUT=1
      IF(JOUT.NE.11)GO TO 111
      DO 43 I=1,LIST
```

```
43      Y1(1)=A(1,NENV)
        GO TO 3333
111     DO 11 I=1,LIST
11      Y1(I)=A(I,NENV)/IV+1
3333    IF(JSENZ.EQ.1)GO TO 9999
543     GO TO (222,222,222,444,444,555,555,666,777,777,333),JOUT
222     CALL OUT6(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,JOVE)
        GO TO 999
333     CALL OUT7(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,JOVE)
        GO TO 999
444     L=IALEA(1,9)
        CALL OUT8(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,FMIN,JOVE)
        GO TO 999
555     CALL OUT9(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,AMIN,JOVE)
        GO TO 999
666     CALL OUT10(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,JOVE)
        GO TO 999
777     CALL OUT11(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,LIN,JOVE)
        GO TO 999
999     CONTINUE
64      CONTINUE
        JREST=IALEA(100000,131000)
        DO 72 I=1,JREST
72      CONTINUE
        MCNT=MCNT+1
        WRITE(4,)MCNT
        JAMP=JAMP-1
        JSENZ=JDUM
        IF(JAMP.NE.0)GO TO 5555
        GO TO 753
123     CONTINUE
9999    JDUM=2
        JSENZ=JDUM
8888    CALL ADC(0,JTEC)
        IF(JTEC.LT.100)GO TO 8888
        GO TO 644
753     CONTINUE
        RETURN
        END
```

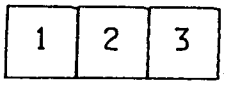
```
      SUBROUTINE FBUBB
C     FBUBB WITH WAV2 ** 0W22,0WW22,0F22,0A22,0L22,0Y22
      INTEGER A,FMIN,AMIN,Y1
      INTEGER INC(50)
      COMMON A(500,17),Y1(500)
      MCNT=0
      CALL RANDOM(1234,X1)
      LISTA=22
      LISTX=LISTA-1
      JSENZ=0
      JDUM=3
      DO 39 I=1,LISTA
39    INC(1)=IALEA(1,30)
      JVAL=23
321   LIST=350
      JAM=4000
      CALL WAVE(LIST,JAM)
      JAMP=LISTA
      LIST4=LIST/4
      LIST2=LIST/2
5555  DO 535 I=1,LISTX
      IF(INC(I+1).LT.INC(I))GO TO 535
      ISWAP=INC(I+1)
      INC(I+1)=INC(I)
      INC(I)=ISWAP
535   CONTINUE
      JVAL=JVAL-1
644   DO 64 II=1,LISTA
      IF(JDUM.NE.2)GO TO 3322
      JDUM=3
      GO TO 543
3322  CONTINUE
      L=INC(II)+JVAL
      IV=IALEA(100,200)
2233  LOW=5
      JWAF=IALEA(1,20)
      IF(JWAF.EQ.9)LOW=1
      JW1=IALEA(LOW,17)
      JW=IALEA(LOW,17)
      NENV=IALEA(8,15)
      LL=L
      NPER=IALEA(1,1)
      MFLAT=IALEA(1,20)
      IF(MFLAT.EQ.9)NPER=IALEA(1,3)
      MPER=NPER
      KDIFF=IALEA(1,10)
      IF(MFLAT.EQ.9.AND.KDIFF.LT.4)MPER=IALEA(1,3)
      JTOT=LIST
      JOVE=1
      IJOO=IALEA(1,20)
      IF(IJOO.EQ.3)JOVE=IALEA(2,4)
      JENV=(LIST+1)*NPER*JOVE/L
      KENV=(LIST+1)*MPER*JOVE/LL
      AMIN=IALEA(1,LIST4)
      LIN=AMIN
      FMIN=AMIN
      JOUT=IALEA(1,64)
      IF(JOUT.GT.11)JOUT=1
      IF(JOUT.NE.11)GO TO 111
      DO 43 I=1,LIST
```

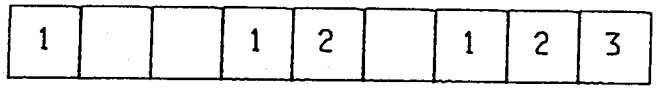
```
43      Y1(1)=A(I,NENV)
        GO TO 3333
111     DO 11 I=1,LIST
11      Y1(I)=A(I,NENV)/IV+1
3333    IF(JSENZ.EQ.1)GO TO 9999
543     GO TO (222,222,222,444,444,555,555,666,777,777,333),JOUT
222     CALL OUT6(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,JOVE)
        GO TO 999
333     CALL OUT7(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,JOVE)
        GO TO 999
444     L=IALEA(1,9)
        CALL OUT8(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,FMIN,JOVE)
        GO TO 999
555     CALL OUT9(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,AMIN,JOVE)
        GO TO 999
666     CALL OUT10(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,JOVE)
        GO TO 999
777     CALL OUT11(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
        1KENV,Y1,LIN,JOVE)
        GO TO 999
999     CONTINUE
64      CONTINUE
        JREST=IALEA(100000,131000)
        DO 72 I=1,JREST
72      CONTINUE
        MCNT=MCNT+1
        WRITE(4,)MCNT
        JAMP=JAMP-1
        JSENZ=JDUM
        IF(JAMP.NE.0)GO TO 5555
        GO TO 753
123     CONTINUE
9999    JDUM=2
        JSENZ=JDUM
8888    CALL ADC(0,JTEC)
        IF(JTEC.LT.100)GO TO 8888
        GO TO 644
753     CONTINUE
        RETURN
        END
```

"TOP12" is a program which calls 3 compositional subroutines: (1) "TDOZS", (2) "TDOZ1S", and (3) "TDOOZ". "TOP12" also determines the duration of a silence after each subroutine call.

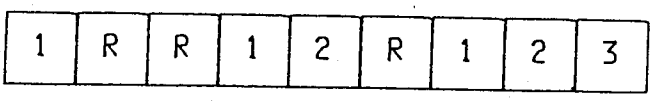
The 3 subroutines are similar in nature, with slight variations. In each routine a sound event series is chosen (with no repetitions). The number of events chosen (n) determines the size of another larger list of sound events of the size (n) squared: (n x n). The original (n) events are then inserted into the larger string according to their location ordinally within the original (n) string in such a way that each set of (n) groups in the larger string (n x n) contains the introduction of one of the (n) values while events inserted in earlier groups are carried over into the next group 'modulo' style.

Below is an illustration of the original event string and the larger string in which the original events are inserted:





After this 'template' type comparison is made the remaining locations of the event string are filled with randomly chosen events:



so that, the number of random events (NR) is determined by:((n)= original number of events)

$$NR=(n-1)+(n-2)+(n-3)...+(n-n)$$

This final event list becomes the actual sounding string. Within two subroutines there is the additional possibility of 'random ornamentation' which can occur between events of the sounding string after the threshold point (n x n)/2 is reached. The ornaments are of a shorter duration and different character than the original events and the number of ornaments that can sound between original events is determined within mask limits whose size depends on the distance into the event string.
Between events (excluding the ornaments) a silence controlling articulation and a rest value are chosen stocastically.

The tendency of an event string is such that repetition increases during the course of the list while the ornamentation serves to oppose this unfolding repetition. These programs were used in the production of "TAPEWALK II".

```
C       TOP12*****************
C               *****TO CALL TDOZS,TDOZ1S,TDOOZ*****
C*****************************************************
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        COMMON A(240,17),Y1(240),Y2(240),Y3(240),Y4(240),
        1S(240),Z(240)
7171    WRITE(4,786)
786     FORMAT(' SEED VALUE,LLTT,JSEED1')
        READ(4,)JSEED,LLTT,JSEED1
        CALL RANDOM(JSEED,X1)
        CALL TOEVAL(JSEED1,.371)
        LO=400
        IGH=500
        JSET=0
C*********************************
55      WRITE(4,)LO,IGH
        JCHOO=IALEA(1,4)
        GO TO (1,2,2,3),JCHOO
1       CALL TDOZS(LLTT)
        GO TO 99
2       CALL TDOZ1S
        GO TO 99
3       CALL TDOOZS(LLTT)
        GO TO 99
C***************************************
C               REST    *
C***************************************
99      IREST=IALEA(LO,IGH)
        WRITE(4,792)
792     FORMAT('          SUBROUTINE PAUSE*********',/)
        DO 11 IWAIT=1,IREST
11      WRITE(4,793)IWAIT
793     FORMAT('+',I6)
        IF(JSET.EQ.0)GO TO 21
        LO=LO+20
        IGH=IGH+20
        GO TO 55
21      LO=LO-20
        IGH=IGH-20
        IF(LO.LT.130)JSET=1
        GO TO 55
        STOP
        END
```

```
C       TDOZS*****************
        SUBROUTINE TDOZS(LLIT)
C       TO CALL F2,F3,F4,F5
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        INTEGER B(20,2),C(200)
        COMMON A(240,17),Y1(240),Y2(240),Y3(240),Y4(240),
        1S(240),Z(240)
7171    WRITE(4,786)
786     FORMAT(' TDOZS')
C*******************************
C       CREATE SERIES           *
C*******************************
9898    MAX=IALEA(3,5)
        WRITE(4,)MAX
        N=1
        B(1,1)=IALEA(1,MAX)
7       K=IALEA(1,MAX)
        DO 1 J=1,N
        IF(K.EQ.B(J,1))GO TO 7
1       CONTINUE
        B(N+1,1)=K
        N=N+1
        IF(N.EQ.MAX)GO TO 13
        GO TO 7
13      CONTINUE
        DO 11 I=1,MAX
11      B(I,2)=IALEA(1,10000)
C*******************************
C       INIT ARRAY              *
C*******************************
        LOC=1
        LOW=1
        IGH=MAX
        MXX=MAX*MAX
        MAX1=MAX+1
        MXX2=MXX/2
        DO 22 I=1,MXX
22      C(I)=0
C*******************************
C       TEMPLATE COMPARISON     *
C*******************************
9090    DO 33 JSE=LOW,IGH
        JSEF=JSE-LOW+1
        IF(C(JSE).NE.0)GO TO 31
        IF(LOC.NE.B(JSEF,1))GO TO 32
        C(JSE)=B(JSEF,2)
31      C(JSE+MAX)=C(JSE)
        GO TO 33
32      C(JSE)=IALEA(1,10000)
33      CONTINUE
        LOC=LOC+1
        IF(LOC.GT.MAX)GO TO 9191
        LOW=LOW+MAX
        IGH=IGH+MAX
        GO TO 9090
9191    CONTINUE
C*******************************
C       MISC...                 *
C*******************************
321     LIST=IALEA(100,200)
```

```
        WRITE(4,)LIST
        JAM=4000
        CALL WAVE(LIST,JAM)
        NIK=1
        NIKI=1
        JCNT=1
        KKNT=1
        LCNT=11
C*********************************
C       OUTPUT ARRAY              *
C*********************************
        DO 66 I0=1,MXX
        JIN=C(I0)
C*********************************
C       INNER RANDOM ORNAMENTS    *
C*********************************
        DO 55 IK=1,NIKI
        CALL RANDOM(JIN,X1)
543     IPER=IALEA(1,2)
        JCH00=IALEA(1,13)
100     GO TO (2,2,2,2,2,2,3,3,3,4,4,4,5),JCH00
2       CALL F2(LIST)
        GO TO 999
3       CALL F3(LIST,IPER)
        GO TO 999
4       CALL F4(LIST,IPER)
        GO TO 999
5       CALL F5(LIST,JAM)
        GO TO 999
999     CONTINUE
        LCNT=LCNT+LLTT
        LLTT=LLTT+7
        CALL RANDOM(LCNT,X1)
        JIN=IALEA(1,10000)
C@@@@@@@@@@@@@@@@@@@@
        JPAUZ=ALEA(1,10,0)
        IF(JPAUZ.GT.3)GO TO 55
        IPAUZ=ALEA(2,30,0)
        DO 197 IPZ=1,IPAUZ
197     WRITE(4,701)IPZ
701     FORMAT('+',I5)
C@@@@@@@@@@@@@@@@@@@@
55      WRITE(4,776)IK
C*********************************
776     FORMAT('+',I4)
        JCNT=JCNT+1
        KKNT=KKNT+1
        IF(JCNT.LT.MAX1)GO TO 65
        JCNT=1
        IF(KKNT.GT.MXX2)NIK=NIK+1
65      NIKI=IALEA(1,NIK)
C*********************************
C       REST??                    *
C*********************************
        JREST=IALEA(1,19)
        IF(JREST.NE.9)GO TO 66
        IREST=IALEA(50,100)
        WRITE(4,792)
792     FORMAT('      PAUZE***************',/)
        DO 67 IWAIT=1,IREST
```

```
 67       WRITE(4,791)IWAIT
 791      FORMAT('+',I5)
 66       WRITE(4,)IO
          RETURN
          END
```

```
C       TDOZ1S*****************
        SUBROUTINE TDOZIS
C       TO CALL F2,F3,F4,F5
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        INTEGER B(20,2),C(200)
        COMMON A(240,17),Y1(240),Y2(240),Y3(240),Y4(240),
        1S(240),Z(240)
        WRITE(4,786)
786     FORMAT(' TDOZ1S')
9898    MAX=IALEA(3,5)
        WRITE(4,)MAX
        N=1
        B(1,1)=IALEA(1,MAX)
7       K=IALEA(1,MAX)
        DO 1 J=1,N
        IF(K.EQ.B(J,1))GO TO 7
1       CONTINUE
        B(N+1,1)=K
        N=N+1
        IF(N.EQ.MAX)GO TO 13
        GO TO 7
13      CONTINUE
        DO 11 I=1,MAX
11      B(I,2)=IALEA(1,10000)
        LOC=1
        LOW=1
        IGH=MAX
        MXX=MAX*MAX
        DO 22 I=1,MXX
22      C(1)=0
9090    DO 33 JSE=LOW,IGH
        JSEF=JSE-LOW+1
        IF(C(JSE).NE.0)GO TO 31
        IF(LOC.NE.B(JSEF,1))GO TO 32
        C(JSE)=B(JSEF,2)
31      C(JSE+MAX)=C(JSE)
        GO TO 33
32      C(JSE)=IALEA(1,10000)
33      CONTINUE
        LOC=LOC+1
        IF(LOC.GT.MAX)GO TO 9191
        LOW=LOW+MAX
        IGH=IGH+MAX
        GO TO 9090
9191    CONTINUE
321     LIST=IALEA(100,200)
        WRITE(4,)LIST
        JAM=4000
        CALL WAVE(LIST,JAM)
        NIK=1
        NIKI=1
        JCNT=1
        LCNT=0
        DO 66 I0=1,MXX
        JIN=C(I0)
        CALL RANDOM(JIN,X1)
543     IPER=IALEA(1,2)
        JCH00=IALEA(1,11)
100     GO TO (2,2,2,2,3,3,3,4,4,4,5),JCH00
2       CALL F2(LIST)
```

```
        GO TO 999
3       CALL F3(LIST,IPER)
        GO TO 999
4       CALL F4(LIST,IPER)
        GO TO 999
5       CALL F5(LIST,JAM)
        GO TO 999
999     CONTINUE
C*******************
        JPAUZ=ALEA(1,10,0)
        IF(JPAUZ.GT.3)GO TO 66
        IPAUZ=ALEA(2,30,0)
        DO 197 IPZ=1,IPAUZ
197     WRITE(4,701)IPZ
701     FORMAT('+',I5)
C*******************
66      WRITE(4,)IO
        RETURN
        END
```

```
C       TDOOZS*****************
        SUBROUTINE TDOOZS(LLTT)
C       TO CALL F2,F3,F4,F5
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        INTEGER B(20,2),C(400)
        COMMON A(500,17),Y1(500),Y2(500),Y3(500),Y4(500),
        1S(500),Z(500)
        WRITE(4,786)
786     FORMAT(' TDOOZS')
C*********************************
C       CREATE SERIES           *
C*********************************
9898    MAX=IALEA(3,6)
        WRITE(4,)MAX
        N=1
        B(1,1)=IALEA(1,MAX)
7       K=IALEA(1,MAX)
        DO 1 J=1,N
        IF(K.EQ.B(J,1))GO TO 7
1       CONTINUE
        B(N+1,1)=K
        N=N+1
        IF(N.EQ.MAX)GO TO 13
        GO TO 7
13      CONTINUE
        DO 11 I=1,MAX
11      B(1,2)=IALEA(1,10000)
C*********************************
C       INIT ARRAY              *
C*********************************
        LOC=1
        LOW=1
        IGH=MAX
        MXX=MAX*MAX
        MAX2=MAX*2
        MAX1=MAX+1
        MXX2=MXX/2
        DO 22 I=1,MXX
22      C(I)=0
C*********************************
C       TEMPLATE COMPARISON     *
C*********************************
9090    DO 33 JSE=LOW,IGH
        JSEF=JSE-LOW+1
        IF(C(JSE).NE.0)GO TO 31
        IF(LOC.NE.B(JSEF,1))GO TO 32
        C(JSE)=B(JSEF,2)
31      C(JSE+MAX)=C(JSE)
        GO TO 33
32      C(JSE)=IALEA(1,10000)
33      CONTINUE
        LOC=LOC+1
        IF(LOC.GT.MAX)GO TO 9191
        LOW=LOW+MAX
        IGH=IGH+MAX
        GO TO 9090
9191    CONTINUE
C*********************************
C       MISC...                 *
C*********************************
```

```
321     LIST=IALEA(100,230)
        WRITE(4,)LIST
        JAM=4000
        CALL WAVE(LIST,JAM)
        NIK=1
        NIKI=1
        JCNT=1
        KKNT=1
        LCNT=11
C*********************************
C       OUTPUT ARRAY              *
C*********************************
        DO 66 IO=1,MXX
        JIN=C(IO)
        JTWO=2
C*********************************
C       INNER RANDOM ORNAMENTS    *
C*********************************
        DO 55 IK=1,NIKI
        CALL RANDOM(JIN,X1)
543     IPER=IALEA(1,JTWO)
        JCHOO=IALEA(1,13)
100     GO TO (2,2,2,2,2,2,3,3,3,4,4,4,5),JCHOO
2       CALL F2(LIST)
        GO TO 999
3       CALL F3(LIST,IPER)
        GO TO 999
4       CALL F4(LIST,IPER)
        GO TO 999
5       CALL F5(LIST,JAM)
        GO TO 999
999     CONTINUE
        LCNT=LCNT+LLTT
        LLTT=LLTT+7
        CALL RANDOM(LCNT,X1)
        JIN=IALEA(1,10000)
        JTWO=1
55      WRITE(4,776)IK
776     FORMAT('+',I4)
C*********************************
        JCNT=JCNT+1
        KKNT=KKNT+1
        IF(JCNT.LT.MAX1)GO TO 65
        JCNT=1
        IF(KKNT.GT.MXX2)NIK=NIK+1
        IF(NIK.GT.4)NIK=4
65      NIKI=IALEA(1,NIK)
C*********************************
C       REST??                    *
C*********************************
        JREST=IALEA(1,MXX)
        IF(JREST.NE.1)GO TO 66
        IREST=IALEA(50,100)
        WRITE(4,792)
792     FORMAT('      PAUZE******',/)
        DO 67 IWAIT=1,IREST
67      WRITE(4,791)IWAIT
791     FORMAT('+',I5)
66      WRITE(4,)IO
        WRITE(4,799)
```

```
799     FORMAT(' ************************************************')
        RETURN
        END
```

"FTOOT1" is a program in which a simple directional tendency is controlled by a random mask which acts on the parameter pitch, causing the frequency range to become higher and narrower over time. Four possible output routines controlling timbre are called with a stochastic weighting in which one timbre can be chosen 50% of the time and the other three each 17%. Duration is effected by the pitch tendency only after a threshold is reached in the pitch range. This program is used in conjunction with "TOP12" and its related subroutines for the composition "TAPEWALK II".

```
C       FTOOT1**************************
C               THIS IS A TEND UP TO GO WITH DOZ.....
C               ++++++++++++++++++++++++++++++++++++
C                   ++++++++++++++++++++++++++
C                       ++++++++++++++++++++
C                           ++++++++++++
C        WITH WAV2 ** 0W22,0WW22,0F22,0A22,0L22,0Y22
        INTEGER FMIN,AMIN,HIGH
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        COMMON A(500,17),Y1(500),Y2(500),Y3(500),Y4(500),
        1S(500),Z(500)
        JAM=4000
        WRITE(4,786)
786     FORMAT(' SEED VALUE?')
        READ(4,)JSEED
        CALL RANDOM(JSEED,X1)
321     LIST=IALEA(200,400)
        WRITE(4,)LIST
        CALL WAVE(LIST,JAM)
        JSET=2
        JCNT=0
        LO=2
        LOX=1
        IGH=4
        IGHX=1
        LIST5=LIST/5
        LIST4=LIST/4
        LIST2=LIST/2
        LIST22=LIST2-5
5555    JW=IALEA(5,17)
        JW1=IALEA(5,17)
        NENV=IALEA(5,15)
        IV=IALEA(100,200)
        JOUT=IALEA(1,6)
        HIGH=IALEA(1,10)
        L=IALEA(LO,IGH)
        IF(JOUT.EQ.5)L=L+2
        IF(JOUT.EQ.6)L=L+3
        IF(JOUT.EQ.4)L=L-1
        LL=L
        IF(HIGH.GT.8)LL=LL+1
        IF(HIGH.LT.3)LL=LL-1
        NPER=IALEA(2,2)
        IF(JSET.LT.2)NPER=1
        MFLAT=IALEA(1,20)
        IF(MFLAT.EQ.9)NPER=IALEA(3,4)
        MPER=NPER
        KDIFF=IALEA(1,10)
        IF(MFLAT.EQ.9.AND.KDIFF.LT.8)MPER=IALEA(1,4)
        JTOT=LIST
        JOVE=IALEA(1,2)
        IJOO=IALEA(1,20)
        IF(IJOO.EQ.3)JOVE=IALEA(3,4)
        JENV=(LIST+1)*NPER*JOVE/L
        KENV=(LIST+1)*MPER*JOVE/LL
        FMIN=IALEA(1,6)
        AMIN=FMIN+6
        LIN=AMIN
111     DO 11 I=1,LIST
11      Y1(I)=A(I,NENV)/IV+1
```

```
      GO TO (222,222,222,444,555,777),JOUT
222   CALL OUT6(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
      GO TO 999
333   CALL OUT7(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
      GO TO 999
444   CALL OUT8(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,FMIN,JOVE)
      GO TO 999
555   CALL OUT9(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,AMIN,JOVE)
      GO TO 999
666   CALL OUT10(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
      GO TO 999
777   CALL OUT11(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,LIN,JOVE)
      GO TO 999
999   JCNT=JCNT+1
      IF(JCNT.LT.3)GO TO 998
      JCNT=0
      LO=LO+LOX
      IGH=IGH+IGHX
998   IF(L.LT.LIST22)GO TO 5555
      JSET=JSET-1
      LO=LO-LIST4
      IGH=IGH-LIST4
      LOX=2
      IGHX=2
      IF(JSET.EQ.0)GO TO 321
      GO TO 5555
      STOP
      END
```

"TSOR3" is a program in which two event string groups are created of 6 notes each and are manipulated as separate groups by a sub-routine "SORT3". "SORT3" contains 7 routines which perform operations of a transfomational nature on the event groups. These 7 routines include:

(1) Rotation of events in which (n) becomes (n+1), etc. and the final group member (nMAX) becomes (n).

(2) Two event locations are chosen randomly and their contents are exchanged.

(3) Event (n+1) and (nMAX-1) are exchanged.

(4) A randomly chosen event is exchanged with its immediate neighbor.

(5) A randomly chosen event is added to the event string in a randomly chosen location.

(6) A randomly chosen event is deleted from the event string.

(7) And most importantly, a randomly chosen event is repeated either once or twice in succession.

Additionally, within "TSOR3" choice is made for either the prime or retrograde version of the string and an increment value through the string which determines the number of events at each sounding of the group.

In "SORT3" a specific sorting routine is chosen in a weighted random manner, while the actual possibility of calling "SORT3" from "TSOR3" is decided via a random mask. Transposition of the entire string is possible in terms of pitch and/or duration.

Two other subroutines may be called by "TSOR3". These are "COPY3" and "COPY33". "COPY33" reproduces the original event strings without transformations via sorting. This original information can be accessed to allow for comparison between sorted versions of the groups and the original versions. "COPY3" allows for the sounding of each group in their entirety without incrementing or retrograde possibilities.

Regarding the pitch transposition possibilities there are 6 possible transpositions which can take place for an entire event string. A weighting is used to control the frequency of choice, with some transpositions having the potential to be chosen more often. These 6 transpositions are used in "TSOR3"; while in "COPY3" and "COPY33" random transpositions within a certain range are possible instead.

Most important compositionally is an overall tendency which controls general characteristics of the event strings. The initial event strings have no events which are repeated. After a certain number of sort manipulations the sort which repeats a random event once or twice successively becomes the most prevalent sort routine (number 7). In this way repetition of small groups of events within each string begins to take place. When a group (which originally contained 6 elements) 'grows' to a total of 13 elements via the repetition sort the tendency 'changes direction' and the sort routine which deletes elements form the group becomes most prominent (number 6). The program halts when only one event is left remaining in a string.

The two groups serve both the function of opposing each other by way of containing contrasting material and yet they both develop in parallel fashion via the tendency secifications. These programs were used in the creation of "T'WHICH".

```
C       TSOR3**************
C       TO CALL F2,F3,F4,F5******* AND SORT3,COPY3,COPY33***
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        INTEGER LST(6)
        COMMON A(500,17),Y1(500),Y2(500),Y3(500),Y4(500),
        1S(500),Z(500),INC(100,4)
9090    WRITE(4,786)
786     FORMAT(' SEED VALUE? AND MAX? AND JSEED1?')
        READ(4,)JSEED,MAX,JSEED1
        CALL RANDOM(JSEED,X1)
        CALL TOEVAL(JSEED1,.779)
        LST(1)=100
        LST(2)=125
        LST(3)=191
        LST(4)=212
        LST(5)=262
        LST(6)=278
        JSEET=20
        LOAD=40
C***************************************
C               CREATE GROUPS    ******
C***************************************
        LISTA=IALEA(6,6)
        LISSA=LISTA
        LISA=LISTA+20
        DO 22 JGRUP=1,MAX
        DO 22 I=1,LISA
        INC(I,JGRUP)=IALEA(1,10000)
22      INC(I,JGRUP+2)=INC(I,JGRUP)
        INC(1,2)=INC(1,2)+1
        INC(1,4)=INC(1,2)
        JGRUP=1
        JCNT=0
2113    CALL COPY33(LISSA,LIST)
        GO TO 1929
213     CALL COPY(LISTA,MAX,LIST)
        GO TO 1929
C***************************************
C               INIT             ******
C***************************************
321     LSTI=IALEA(1,10)
        IF(LSTI.GT.6)LSTI=1
        IF(LSTI.GT.8)LSTI=2
        LIST=LST(LSTI)
        JAM=4000
        CALL WAVE(LIST,JAM)
123     JRETRO=IALEA(1,100)
        INK=IALEA(1,2)
        WRITE(4,714)
714     FORMAT('    LIST    JGRUP JCHO  INK   JCNT')
        WRITE(4,711)LIST,JGRUP,JCHO,INK,JCNT
711     FORMAT(1X,5(I6))
        IF(JRETRO.GT.50)GO TO 654
C***************************************
C               PRIME           *******
C***************************************
5555    WRITE(4,753)
753     FORMAT(' **PRIME**',/)
        DO 999 IO=1,LISTA,INK
        CALL RANDOM(INC(IO,JGRUP),X1)
```

```
        IPER=IALEA(1,2)
        JCHOO=IALEA(1,9)
        GO TO (2,2,2,2,3,3,4,4,5),JCHOO
2       CALL F2(LIST)
        GO TO 999
3       CALL F3(LIST,IPER)
        GO TO 999
4       CALL F4(LIST,IPER)
        GO TO 999
5       CALL F5(LIST,JAM)
        GO TO 999
999     CONTINUE
        GO TO 1929
C**************************************
C               RETRO           *******
C**************************************
        GO TO 1929
654     WRITE(4,741)
741     FORMAT(' **RETRO**',/)
        DO 888 IO=LISTA,1,-INK
        CALL RANDOM(INC(IO,JGRUP),X1)
        IPER=IALEA(1,2)
        JCHOO=IALEA(1,6)
        GO TO (12,12,12,13,14,15),JCHOO
12      CALL F2(LIST)
        GO TO 888
13      CALL F3(LIST,IPER)
        GO TO 888
14      CALL F4(LIST,IPER)
        GO TO 888
15      CALL F5(LIST,JAM)
        GO TO 888
888     CONTINUE
C**************************************
C               CHOOSE SORT # AND CALL*
C**************************************
1929    ICNT=ALEA(1,10000,0)
        JCNT=JCNT+1
        CALL RANDOM(ICNT,X1)
        IF(JCNT.LT.2)GO TO 213
        JGRUP=IALEA(1,MAX)
        NSORT=IALEA(1,100)
        IF(JSEET.EQ.10)LOAD=80
        IF(NSORT.GT.LOAD)GO TO 1939
        CALL SORT(LISTA,JGRUP,JCHO,JSEET,JCNT)
        WRITE(4,765)
765     FORMAT(' ** NEW SORT **')
        GO TO 1949
1939    WRITE(4,766)
766     FORMAT(' **NO NEW SORT**')
1949    IF(INK.GT.1)GO TO 1951
C**************************************
C               SIL.*
C**************************************
        IREST=IALEA(10,250)
        WRITE(4,792)
792     FORMAT('         PAUZE********',/)
        DO 67 IWAIT=1,IREST
67      WRITE(4,791)IWAIT
791     FORMAT('+',I5)
```

```
1951    NLIS=IALEA(1,100)
        IF(NLIS.GT.70)GO TO 123
        IF(NLIS.LT.11)GO TO 213
        IF(NLIS.LT.24)GO TO 2113
        GO TO 321
        STOP
        END
```

```
C*************** SORT3 ****************
      SUBROUTINE SORT(LISTA,IX,JCHO,JSEET,JCNT)
      INTEGER A,Y1,Y2,Y3,Y4,S,Z
      COMMON A(500,17),Y1(500),Y2(500),Y3(500),Y4(500),
      1S(500),Z(500),INC(100,4)
      JCHO=IALEA(1,18)
      IF(JCNT.LT.12)JCHO=IALEA(1,9)
      IF(LISTA.GT.11)JSEET=10
      IF(JSEET.GT.10)GO TO 188
      IF(JCHO.GT.10)JCHO=10
      WRITE(4,877)
877   FORMAT(' NOTICE:REPETITION BLOCKED************************')
188   GO TO (1,1,2,2,5,5,6,6,9,8,7,7,7,7,7,7,7,7),JCHO
C1*************************************
C     KRENEK ROTATION
C*************************************
1     JSTO=INC(1,IX)
      LISTX=LISTA-1
      DO 199 I=1,LISTX
199   INC(I,IX)=INC(I+1,IX)
      INC(LISTA,IX)=JSTO
      GO TO 101
C2*************************************
C     EXCHANGE RANDOM LOCS.
C*************************************
2     K=IALEA(1,LISTA)
      L=IALEA(1,LISTA)
      ISWAP=INC(K,IX)
      INC(K,IX)=INC(L,IX)
      INC(L,IX)=ISWAP
      GO TO 101
C3*************************************
C     INVERT VAL. IN RANDOM LOC
C*************************************
3     K=IALEA(1,LISTA)
      IF(INC(K,IX).GT.5000)GO TO 214
      INC(K,IX)=INC(K,IX)+5000
      GO TO 215
214   INC(K,IX)=INC(K,IX)-5000
215   CONTINUE
      GO TO 101
C4*************************************
C     REPLACE 2 LOCS. WITH RAN. VALS.
C*************************************
4     DO 22 I=1,2
      M=IALEA(1,10000)
      ML=IALEA(1,LISTA)
22    INC(ML,IX)=M
      GO TO 101
C5*************************************
C     EXCHANGE 2ND & PENULTIMATE LOCS.
C*************************************
5     J=1
      ISWAP=INC(J+1,IX)
      INC(J+1,IX)=INC(LISTA-1,IX)
      INC(LISTA-1,IX)=ISWAP
      GO TO 101
C6*************************************
C     EXCHANGE NEIGHBOR VALS.
C*************************************
```

```
6       LISTX=LISTA-1
        L=IALEA(1,LISTX)
        ISWAP=INC(L,IX)
        INC(L,IX)=INC(L+1,IX)
        INC(L+1,IX)=ISWAP
111     CONTINUE
        GO TO 101
C7**************************************
C       REPETITION OF RAN. VAL. X##
C**************************************
7       L=IALEA(1,LISTA)
        JADD=IALEA(1,2)
        LISTA=LISTA+JADD
        L1=L+JADD
        DO 31 I=LISTA,L1,-1
31      INC(I,IX)=INC(I-JADD,IX)
        DO 33 I=1,JADD
33      INC(L+I,IX)=INC(L,IX)
        GO TO 101
C8**************************************
C       DELETION OF RAN. VAL.
C**************************************
8       IF(LISTA.LT.2)GO TO 9
        L=IALEA(1,LISTA)
        DO 44 I=L,LISTA
44      INC(I,IX)=INC(I+1,IX)
        LISTA=LISTA-1
        GO TO 101
C9**************************************
C       ADD ONE TO STRING RAN.
C**************************************
9       L=IALEA(1,LISTA)
        LISTA=LISTA+1
        L1=L+1
        DO 98 I=LISTA,L1,-1
98      INC(I,IX)=INC(I-1,IX)
        INC(L+1,IX)=IALEA(1,10000)
        GO TO 101
C**************************************
C** ** ** ** ** ** ** ** ** ** ** **
101     WRITE(4,)LISTA
        RETURN
        END
```

```
C       COPY3**************
C       CALLED BY TSOR3*****
C       TO CALL F2,F3,F4,F5*******
        SUBROUTINE COPY(LISTA,MAX,LIST)
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        COMMON A(500,17),Y1(500),Y2(500),Y3(500),Y4(500),
        1S(500),Z(500),INC(100,4)
        WRITE(4,777)
777     FORMAT(' ***** COPY3 *****')
321     LIST=IALEA(100,200)
        WRITE(4,)LIST
        JAM=4000
        CALL WAVE(LIST,JAM)
        DO 999 JWH=1,MAX
        WRITE(4,)JWH
        DO 999 I0=1,LISTA,1
        CALL RANDOM(INC(I0,JWH),X1)
        IPER=IALEA(1,2)
        JCH00=IALEA(1,9)
        GO TO (2,2,2,2,3,3,4,4,5),JCH00
2       CALL F2(LIST)
        GO TO 999
3       CALL F3(LIST,IPER)
        GO TO 999
4       CALL F4(LIST,IPER)
        GO TO 999
5       CALL F5(LIST,JAM)
        GO TO 999
999     CONTINUE
        RETURN
        STOP
```

```
C       COPY33**************
C       CALLED BY TSOR3*****
C       TO CALL F2,F3,F4,F5*******
        SUBROUTINE COPY33(LISSA,LIST)
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        COMMON A(500,17),Y1(500),Y2(500),Y3(500),Y4(500),
        1S(500),Z(500),INC(100,4)
        WRITE(4,777)
777     FORMAT(' ***** COPY33 *****')
321     LIST=IALEA(100,250)
        WRITE(4,)LIST
        JAM=4000
        CALL WAVE(LIST,JAM)
        DO 999 JWH=3,4
        WRITE(4,)JWH
        DO 999 IO=1,LISSA,1
        CALL RANDOM(INC(IO,JWH),X1)
        IPER=IALEA(1,2)
        JCHOO=IALEA(1,9)
        GO TO (2,2,2,2,3,3,4,4,5),JCHOO
2       CALL F2(LIST)
        GO TO 999
3       CALL F3(LIST,IPER)
        GO TO 999
4       CALL F4(LIST,IPER)
        GO TO 999
5       CALL F5(LIST,JAM)
        GO TO 999
999     CONTINUE
        RETURN
        STOP
```

"T00" is unique among these programs for two reasons: (1) the use of the switch register in the final form of the program and (2) the use of additional hardware consisting of an analog-to-digital convertor. The function of these two items is to allow for flexible input possibilities in real-time.

The switch register is divided into four sections to allow for the input of four variable values and the ADC is used for the input of a fifth variable value via a 0 to 10 volt power supply controlled by a potentiometer. This program was the last to be developed in the course of this project and the real-time 'performance' possibilities were added when it became evident that this flexibility was necessary in order to articulate the musical potential and relationships of this program.

The main function of the program is the transformation of individual parameters of sound events. The three parameters frequency, duration, and timbre can be tied or untied in any combination in relation to each other within a single sound event. This gives a combinatorial maximum of six tied/untied possible relationships for a sound event which are controlled by a stochastic process between clearly defined limits which allows for event modifications ranging from very slight to very large without losing basic individualising characteristics of the original sound event.

Two random number generators were employed and a set of 63 sound events were used as a template from which to work. (Because of the transformational possibilities 63 events was more than enough.) Via the switch register a beginning event, a final event, and an increment value for specifying events in the range could be entered. In this way I had control of event sequences while leaving the details of parametric transformations to the computer. Also, via the switches, specification could be given for general parametric considerations involving pitch and duration characteristics of entire strings of events. Futhermore,by way of the ADC, event articulation and silence between events could be controlled. Three FORTRAN subroutines were called by "T00": "ONE1", "TWO1", and "THRE1". These routines made the actual transformations to specific

events with information sent from "T00", and they in turn called MACRO sounding routines. All in all the possibilities inherent in the transformation of specific parameters was best articulated with the potential for a more 'performance' oriented environment. These programs were used in the creation of "T'WHICH".

```
C**********TOO  WITH ADC********
C       TAM11*******TO CALL: ONE1,TWO1,THRE1
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        INTEGER C(100)
        COMMON A(500,17),Y1(500),Y2(500),Y3(500),Y4(500),
        1S(500),Z(500)
9898    WRITE(4,786)
786     FORMAT(' SEED VALUE?,MAX?,JSEED1')
        READ(4,)JSEED,MAX,JSEED1
        CALL RANDOM(JSEED,X1)
        CALL TOEVAL(JSEED1,.799)
C**************************************
C               1N1T. LIST & ETC.*
C**************************************
        LIST=1ALEA(100,200)
        LIST=177
        JAM=4000
        JSET=0
        GO TO 390
C**************************************
C               INIT.
C**************************************
321     LIST=IALEA(50,250)
390     WRITE(4,)LIST
        LIST4=LIST/4
        LIST5=LIST/5
        JSET=JSET+1
        IF(JSET.GT.1)GO TO 212
C**************************************
C               SET UP ARRAY
C**************************************
        DO 1 J=1,MAX
1       C(J)=IALEA(1,10000)
C**************************************
C               READ SWITCHES
C**************************************
212     CALL WAVE(LIST,JAM)
21      CALL SNSACS(NON)
        MON=NON[12:17]
        MON1=NON[6:11]
        MON2=NON[0:2]
        MOLIS=NON[3:5]
        WRITE(4,)MON,MON1,MON2,MOLIS
C**************************************
C               START LOOP*****************************
C**************************************
        DO 66 IO=MON,MON1,MON2
        MSEM=IALEA(1,100)
        IF(MSEM.GT.90)GO TO 9
        GO TO 91
C**************************************
C       CHANGE ONE PARAMETER    *
C**************************************
9       ICOO=IALEA(1,7)
        GO TO (10,10,10,20,20,20,30),ICOO
10      JTIM=IALEA(1,3)
        JNEG=IALEA(1,100)
        IF(JNEG.GT.50)JTIM=-JTIM
        GO TO 654
20      IPCH=IALEA(1,13)
```

```
        JNEG1=IALEA(1,100)
        IF(JNEG1.GT.50)IPCH=-IPCH
        GO TO 654
30      MDUR=IALEA(100,500)
        MDUR1=IALEA(1,3)
        JNEG2=IALEA(1,100)
        IF(JNEG2.GT.50)MDUR=-MDUR
        IF(JNEG2.GT.50)MDUR1=-MDUR1
        GO TO 654
C***************************************
C       CHANGE ALL PARAMETERS           *
C***************************************
91      JTIM=IALEA(1,3)
        JNEG=IALEA(1,100)
        IF(JNEG.GT.50)JTIM=-JTIM
        IPCH=IALEA(1,13)
        JNEG1=IALEA(1,100)
        IF(JNEG1.GT.50)IPCH=-IPCH
        NUM=IALEA(1,100)
        IF(NUM.GT.25)GO TO 654
        MDUR=IALEA(100,500)
        MDUR1=IALEA(1,3)
        JNEG2=IALEA(1,100)
        IF(JNEG2.GT.50)MDUR=-MDUR
        IF(JNEG2.GT.50)MDUR1=-MDUR1
C***************************************
C               CALL OUTPUT ROUTINES***
C***************************************
654     WRITE(4,)IO
        IF(IO.EQ.0)GO TO 5
        CALL RANDOM(C(IO),X1)
543     IPER=IALEA(1,3)
        JCHOO=IALEA(1,8)
100     GO TO (2,2,2,3,3,4,4,5),JCHOO
2       CALL F2(LIST,LIST4,LIST5,JTIM,IPCH,MDUR1,ICOO,NUM,MSEM)
        GO TO 999
3       CALL F3(LIST,LIST4,LIST5,IPER,JTIM,IPCH,MDUR,ICOO,NUM,MSEM)
        GO TO 999
4       CALL F4(LIST,LIST4,LIST5,IPER,JTIM,IPCH,MDUR,ICOO,NUM,MSEM)
        GO TO 999
5       LCNT=ALEA(1,10000,0)
        CALL RANDOM(LCNT,X1)
        CALL F5(LIST,JAM)
        GO TO 999
999     CONTINUE
109     LCNT=ALEA(1,10000,0)
        CALL RANDOM(LCNT,X1)
C*************************
        IREST=0
C*************************
C       CALL ADC(0,IREST)
        IF(IREST.LT.1)GO TO 66
        WRITE(4,792)
792     FORMAT('       PAUZE****',/)
        DO 67 IWAIT=1,IREST
67      WRITE(4,791)IWAIT
791     FORMAT('+',I5)
66      CONTINUE
C***********************************
C               END LOOP*************************************
```

```
C************************************
      IF(MOLIS.GT.0)GO TO 321
      GO TO 21
      STOP
      END
```

```
C       F2TRM*****************************************
C       F2************************
C        WITH WAV2 ** 0W22,0WW22,0F22,0A22,0L22,0Y22
        SUBROUTINE F2(LIST,JTIM,IPCH,MDUR1,ICOO,NUM,MSEM)
        INTEGER FMIN,AMIN,HIGH
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        COMMON A(500,17),Y1(500),Y2(500),Y3(500),Y4(500),
        1S(500),Z(500)
        LIST5=LIST/5
        LIST4=LIST/4
5555    JW=IALEA(5,17)
        JW1=IALEA(5,17)
        NENV=IALEA(5,15)
        IV=IALEA(100,200)
        HIGH=IALEA(1,10)
        L=IALEA(6,LIST5)
        IF(HIGH.EQ.9)L=IALEA(8,LIST4)
        NPER=1
        MFLAT=IALEA(1,50)
        IF(MFLAT.EQ.9)NPER=IALEA(2,4)
        JOVE=1
        IJOO=IALEA(1,50)
        IF(IJOO.EQ.3)JOVE=IALEA(2,4)
        JOUT=IALEA(1,4)
        GO TO 9
C***************************************
        IF(NUM.GT.47)GO TO 9
        IF(NUM.GT.44)GO TO 91
        IF(MSEM.GT.8)GO TO 9
        IF(MSEM.GT.5)GO TO 91
        GO TO 4
C***************************************
9       GO TO (1,2,3),ICOO
1       JOUT=JOUT+JTIM
        IF(JOUT.LT.1)JOUT=JOUT+4
        IF(JOUT.GT.4)JOUT=JOUT-4
        GO TO 4
2       L=L+IPCH
        IF(L.LT.1)L=L+LIST4
        IF(L.GT.LIST4)L=L-LIST4
        GO TO 4
3       NPER=NPER+MDUR1
        IF(NPER.LT.1)NPER=NPER+4
        IF(NPER.GT.4)NPER=NPER-4
        JOVE=JOVE-MDUR1
        IF(JOVE.LT.1)JOVE=JOVE+4
        IF(JOVE.GT.4)JOVE=JOVE-4
        GO TO 4
C
C*********************************
91      JOUT=JOUT+JTIM
        IF(JOUT.LT.1)JOUT=JOUT+4
        IF(JOUT.GT.4)JOUT=JOUT-4
        L=L+IPCH
        IF(L.LT.1)L=L+LIST4
        IF(L.GT.LIST4)L=L-LIST4
        IDUR=IALEA(1,10)
        IF(IDUR.GT.3)GO TO 4
        NPER=NPER+MDUR1
        IF(NPER.LT.1)NPER=NPER+4
```

```
      IF(NPER.GT.4)NPER=NPER-4
      JOVE=JOVE-MDUR1
      IF(JOVE.LT.1)JOVE=JOVE+4
      IF(JOVE.GT.4)JOVE=JOVE-4
C
C*********************************
C
C*********************************
4     LL=L
      MPER=NPER
      KDIFF=IALEA(1,10)
      IF(MFLAT.EQ.9.AND.KDIFF.LT.4)MPER=IALEA(1,4)
      JTOT=LIST
      JENV=(LIST+1)*NPER*JOVE/L
      KENV=(LIST+1)*MPER*JOVE/LL
      AMIN=IALEA(1,LIST4)
      FMIN=AMIN
      LIN=AMIN
      JJJ=IALEA(1,25)
      IF(JJJ.NE.9)GO TO 111
      IV=1
111   DO 11 I=1,LIST
11    Y1(I)=A(I,NENV)/IV+1
      IF(JJJ.EQ.3)JOUT=5
      IF(JJJ.EQ.9)JOUT=6
      GO TO (222,444,555,777,666,333),JOUT
222   CALL OUT6(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
      GO TO 999
333   CALL OUT7(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
      GO TO 999
444   L=IALEA(1,8)
      LL=L
      CALL OUT8(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,FMIN,JOVE)
      GO TO 999
555   CALL OUT9(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,AMIN,JOVE)
      GO TO 999
666   CALL OUT10(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,JOVE)
      GO TO 999
777   CALL OUT11(A(1,JW),NPER,MPER,L,LL,LIST,JTOT,A(1,JW1),JENV,
     1KENV,Y1,LIN,JOVE)
      GO TO 999
999   CONTINUE
      RETURN
      END
```

```
C       F3TRM*************************************************
C       F3*******************
C       WITH WAV2,0IN3,0FM3,0AM3,0LAY3,0IN33
        SUBROUTINE F3(LIST,IPER,JTIM,IPCH,MDUR,IC00,NUM,MSEM)
        INTEGER FMIN,FMIM,AMIN,AMIM
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        COMMON A(500,17),Y1(500),Y2(500),Y3(500),Y4(500),
        1S(500),Z(500)
        LIST4=(LIST/4)-2
        LIST5=LIST/5
        GO TO (1,2,3,4,5),IPER
1       IGH=100
        NON=25
        GO TO 555
2       IGH=500
        NON=20
        GO TO 555
3       IGH=1000
        NON=15
        GO TO 555
4       IGH=1500
        NON=10
        GO TO 555
5       IGH=2500
        NON=7
555     CONTINUE
567     JSWQ=IALEA(1,10)
        IF(JSWQ.GT.1)GO TO 5454
        JW=IALEA(1,17)
        JW1=IALEA(1,17)
        GO TO 6666
5454    JW=IALEA(5,17)
        JW1=IALEA(5,17)
6666    NENV=IALEA(5,15)
        NENV1=IALEA(5,15)
        IV=IALEA(100,200)
        IV1=IALEA(100,200)
        JJJ=IALEA(1,25)
        IF(JJJ.NE.9)GO TO 111
        IV=1
        IV1=1
111     DO 11 I=1,LIST
        Y1(1)=A(I,NENV)/IV+1
11      Y2(I)=A(I,NENV1)/IV1+1
888     L=IALEA(4,LIST4)
        LL=IALEA(4,LIST4)
        JSWI=IALEA(1,4)
        GO TO 9
C*************************************
        IF(NUM.GT.47)GO TO 9
        IF(NUM.GT.44)GO TO 91
        IF(MSEM.GT.8)GO TO 9
        IF(MSEM.GT.5)GO TO 91
        GO TO 40
C*************************************
C*********************************
C
9       GO TO (10,20,30),IC00
10      JSWI=JSWI+JTIM
        IF(JSWI.LT.1)JSWI=JSWI+4
```

```
      IF(JSWI.GT.4)JSWI=JSWI-4
      GO TO 40
20    L=L+IPCH
      IF(L.LT.2)L=L+LIST4
      IF(L.GT.LIST4)L=L-LIST4
      LL=LL-IPCH
      IF(LL.LT.2)LL=LL+LIST4
      IF(LL.GT.LIST4)LL=LL-LIST4
      GO TO 40
30    IGH=IGH+MDUR
      IGH1=IGH-MDUR
      IF(IGH.LT.100)IGH=IGH+900
      IF(IGH.GT.1000)IGH=IGH-900
      IF(IGH1.LT.100)IGH1=IGH1+900
      IF(IGH1.GT.1000)IGH1=IGH1-900
      GO TO 40
C
C*********************************
C*********************************
C
91    JSWI=JSWI+JTIM
      IF(JSWI.LT.1)JSWI=JSWI+4
      IF(JSWI.GT.4)JSWI=JSWI-4
      L=L+IPCH
      IF(L.LT.2)L=L+LIST4
      IF(L.GT.LIST4)L=L-LIST4
      LL=LL-IPCH
      IF(LL.LT.2)LL=LL+LIST4
      IF(LL.GT.LIST4)LL=LL-LIST4
      IGH=IGH+MDUR
      IGH1=IGH-MDUR
      IF(IGH.LT.100)IGH=IGH+900
      IF(IGH.GT.1000)IGH=IGH-900
      IF(IGH1.LT.100)IGH1=IGH+900
      IF(IGH1.GT.1000)IGH1=IGH1-900
C
C*********************************
40    NPER=IALEA(25,IGH)
      MPER=IALEA(25,IGH1)
      JENV=NPER/L
      KENV=MPER/LL
      FMIN=IALEA(1,LIST4)
      FMIM=IALEA(1,LIST4)
      AMIN=FMIN
      AMIM=FMIM
      IF(JJJ.EQ.3)JSWI=5
      IF(JJJ.EQ.9)JSWI=6
      GO TO (222,222,333,444,666,777),JSWI
222   CALL OUT12(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2)
      GO TO 999
333   CALL OUT13(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2,FMIN,FMIN)
      GO TO 999
444   CALL OUT14(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2,AMIN,AMIN)
      GO TO 999
666   CALL OUT15(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
     1JENV,KENV,Y1,Y2)
      GO TO 999
```

```
777     CALL OUT16(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),
       1JENV,KENV,Y1,Y2)
        GO TO 999
999     CONTINUE
        RETURN
        END
```

```
C       F4TRM*******************************************_
C       F4**********************
C       WITN OIN4,OIN44,OIN45,OFM4,OAM4,OLAY4
        SUBROUTINE F4(LIST,IPER,JTIM,IPCH,MDUR,ICOO,NUM,MSEM)
        INTEGER FMIN,FMIN1,FMIN2,FMIN3,AMIN,AMIN1,AMIN2,AMIN3
        INTEGER A,Y1,Y2,Y3,Y4,S,Z
        COMMON A(500,17),Y1(500),Y2(500),Y3(500),Y4(500),
        1S(500),Z(500)
        LIST4=(LIST/4)-4
        LIST5=LIST/5
        GO TO (1,2,3,4,5),IPER
1       IGH=100
        GO TO 555
2       IGH=350
        GO TO 555
3       IGH=700
        GO TO 555
4       IGH=1000
        GO TO 555
5       IGH=1500
555     IV=IALEA(100,200)
        IV1=IALEA(100,200)
        IV2=IALEA(100,200)
        IV3=IALEA(100,200)
        JSWQ=IALEA(1,10)
        IF(JSWQ.GT.2)GO TO 5555
        JW=IALEA(1,17)
        JW1=IALEA(1,17)
        JW2=IALEA(1,17)
        JW3=IALEA(1,17)
        GO TO 666
5555    JW=IALEA(5,17)
        JW1=IALEA(5,17)
        JW2=IALEA(5,17)
        JW3=IALEA(5,17)
666     NENV=IALEA(5,15)
        NENV1=IALEA(5,15)
        NENV2=IALEA(5,15)
        NENV3=IALEA(5,15)
        JJJ=IALEA(1,25)
        IF(JJJ.NE.9)GO TO 111
        IV=1
        IV1=IV
        IV2=IV
        IV3=IV
111     DO 11 I=1,LIST
        Y1(1)=A(I,NENV)/IV+1
        Y2(I)=A(I,NENV1)/IV1+1
        Y3(1)=A(1,NENV2)/IV2+1
11      Y4(I)=A(I,NENV3)/IV3+1
888     LIST1=LIST4
        JSWI=IALEA(1,5)
        IF(JSWI.GT.7.AND.JJJ.NE.9)LIST1=LIST1+LIST1-41
        L=IALEA(4,LIST1)
        LL=IALEA(4,LIST1)
        LLL=IALEA(4,LIST1)
        LLLL=IALEA(4,LIST1)
        GO TO 9
C***********************************
        IF(NUM.GT.47)GO TO 9
```

```
        IF(NUM.GT.44)GO TO 91
        IF(MSEM.GT.8)GO TO 9
        IF(MSEM.GT.5)GO TO 91
        GO TO 40
C***************************************
C***************************************
C
9       GO TO (10,20,30),ICOO
10      JSWI=JSWI+JTIM
        IF(JSWI.LT.1)JSWI=JSWI+5
        IF(JSWI.GT.5)JSWI=JSWI-5
        GO TO 40
20      L=L+IPCH
        IF(L.LT.4)L=L+LIST1
        IF(L.GT.LISTI)L=L-LISTI
        LL=LL-IPCH
        IF(LL.LT.4)LL=LL+LISTI
        IF(LL.GT.LIST1)LL=LL-LIST1
        GO TO 40
30      IGH=IGH+MDUR
        IGH1=IGH-MDUR
        IF(IGH.LT.100)IGH=IGH+600
        IF(IGH.GT.700)IGH=IGH-600
        IF(IGH1.LT.100)IGH1=IGH1+600
        IF(IGH1.GT.700)IGH1=IGH1-600
        GO TO 40
C
C***************************************
C***************************************
C
91      JSWI=JSWI+JTIM
        IF(JSWI.LT.1)JSWI=JSWI+5
        IF(JSWI.GT.5)JSWI=JSWI-5
        L=L+IPCH
        IF(L.LT.4)L=L+LIST1
        IF(L.GT.LISTI)L=L-LISTI
        LL=LL-IPCH
        IF(LL.LT.4)LL=LL+LISTI
        IF(LL.GT.LIST1)LL=LL-LIST1
        IGH=IGH+MDUR
        IGH1=IGH-MDUR
        IF(IGH.LT.100)IGH=IGH+600
        IF(IGH.GT.700)IGH=IGH-600
        IF(IGH1.LT.100)IGH1=IGH+600
        IF(IGH1.GT.700)IGH1=IGH1-600
C
C***************************************
C***************************************
40      NPER=IALEA(25,IGH)
        MPER=IALEA(25,IGH1)
        JPER=IALEA(25,IGH)
        KPER=IALEA(25,IGH1)
        JENV=NPER/L
        KENV=MPER/LL
        LENV=JPER/LLL
        MENV=KPER/LLLL
        FMIN=IALEA(4,LIST4)
        FMIN1=IALEA(4,LIST4)
        FMIN2=IALEA(4,LIST4)
        FMIN3=IALEA(4,LIST4)
```

```
      IF(JJJ.EQ.9)JSWI=7
      IF(JJJ.EQ.3)JSWI=6
      GO TO (222,222,1010,444,333,1111,777),JSWI
  222 CALL OUT17(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
      GO TO 999
  777 CALL OUT18(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
      GO TO 999
 1010 CALL OUT19(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
      GO TO 999
  333 CALL OUT20(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4,FMIN,FMIN1,FMIN2,FMIN3)
      GO TO 999
  444 CALL OUT21(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4,FMIN,FMIN1,FMIN2,FMIN3)
      GO TO 999
 1111 CALL OUT22(A(1,JW),NPER,MPER,L,LL,LIST,A(1,JW1),JENV,KENV,
     1Y1,Y2,A(1,JW2),JPER,KPER,LLL,LLLL,A(1,JW3),
     1LENV,MENV,Y3,Y4)
  999 CONTINUE
      RETURN
      END
```