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Dual-Voice Music Synthesizer

by Lee Morgenstern

Those of you who are bored with your computer playing only one note at a time can learn how to get multiple notes through software.

Are you tired of hearing only single-note-at-a-time tunes from your TRS-80? This program demonstrates how to create musical pieces that play through the cassette port and have both treble and bass voices. Best of all, it requires no extra hardware.

Some musical pieces require two voices. Previously, hardware music synthesizers, which are expensive, were the only way to produce multiple voices. Now, however, it is possible to produce them completely with software.

Theory of Operation

Other programs produce music by generating square waves with two amplitudes, or voltage levels, and causing the cassette output to vibrate. This program creates a more advanced wave by controlling the three voltage levels available at the cassette port. With three levels, it produces a wave resulting from the amplitude addition of two separate square waves as in Fig. 1. When the program sends this wave through the cassette port, the output sounds like two independent tones played at the same time.

Programming amplitude addition is not as tricky as you might think. The cassette commands have an interesting pattern. Table 1 shows the binary command values that produce the three voltage levels at the cassette auxiliary output.

Bit 2 turns on the cassette motor and bits 0 and 1 control the voltage. Complementing either bit 0 or 1 produces a voltage change of one level by "vibrating" bit 1 to produce the treble notes and independently doing the same to bit 0 to produce the bass notes.

command bit:	2	1	0		
	1	1	0	=	0.00 volts
	1	1	1	=	0.46 volts
	1	0	0	=	0.46 volts
	1	0	1	=	0.85 volts

Table 1. Cassette-port Command Values for the Voltage Levels

Variable	Meaning
M$	USR machine code
N$	names of the notes
N	frequency counts of the notes
T()	treble note list
B()	bass note list
D()	dual-voice play buffer

Table 2. Important Basic Variables

Byte	Contents
1	note duration MSB
2	note duration LSB
3	treble note frequency count
4	treble note octave count
5	bass note frequency count
6	bass note octave count
7	treble note rest flag—2 if played, 0 if rest
8	bass note rest flag—1 if played, 0 if rest

Table 3. Play Buffer Format

Program Features

The Dual-Voice Music Synthesizer is written in Basic and Assembly language. The Basic part creates and edits a list of treble and bass notes, and an Assembly-language USR subroutine plays the music. The program uses

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Cassette or Disk Basic
Cassette Port Amplifier
Printer Optional

POKE statements to enter the USR machine code into a string.

The musical capabilities of the program are a 5-octave note range, whole note to 64th note timing, sharps, and rests. In a 16K TRS-80, there is room for 700 notes for treble and bass each. In a 48K machine, this expands to 3,400 notes each.

The music plays through an amplifier and speaker, or records on cassette tape, while a special feature changes the timing of the piece.

The file handling provides loading and saving of music files using either cassette or disk. The editing features consist of append, insert, delete, display, and print functions for both treble and bass note lists.

Entering the Program

Type Program Listing 1 exactly as it appears and it will work for Level II Basic or Disk Basic. You may, however, remove certain lines depending on your system.

For Level II Basic using a cassette, you may omit lines 1650–1800, 1880–2030, 3610–3650, and 3670–3710.

For Disk Basic using disks for file storage, you may omit lines 1650–1720, 1800–1840, 1880–1950, 2030–2070, 3610–3650, 3670, and 3720–3750.

For Disk Basic using cassette for file storage, you may omit lines 1650–1790, 1880–2020, 3610–3650, 3670, and 3720–3750.

Operating the Program

A typical procedure for creating and playing music consists of the following steps:

- Enter the treble and bass notes using the editing functions.
- Save the note lists on disk or tape.
- Build the play buffer.
- Play the music.
- Change the timing if necessary.

Two menus contain all the program

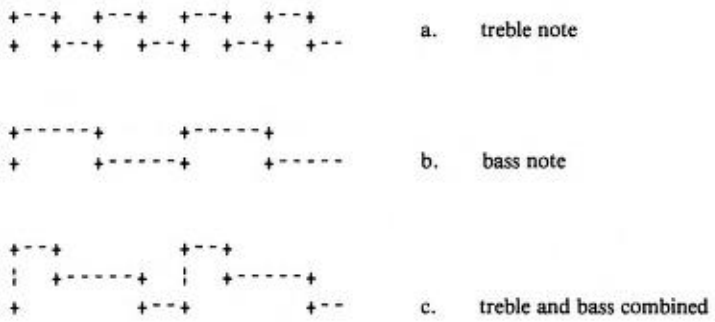

Fig. 1. Two voices are created by adding the amplitudes of two waves. The two waves (1a and 1b), each having two amplitude levels, combine to form wave 1c, having three amplitude levels.

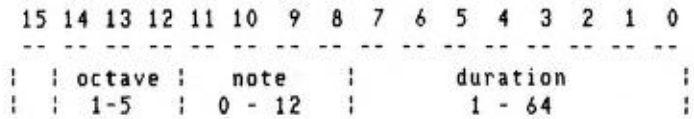

Fig. 2. Packing of Treble and Bass Notes

Program Listing 1

```
1000 'DUAL-VOICE MUSIC SYNTHESIZER
1010 'BY LEE MORGENSTERN, MAY, 1982
1020 '
1030 CLS: CLEAR 256: DEFINT A-Z
1040 PRINT"DUAL-VOICE MUSIC SYNTHESIZER"
1050 PRINT: PRINT"READING DATA:"
1060 E1$="TREBLE OR BASE LIST EMPTY"
1070 E2$="PLAY BUFFER NOT BUILT"
1080 E3$="NOTE LIST EMPTY"
1090 E4$="IMPROPER NOTE"
1100 E5$="IMPROPER OCTAVE"
1110 M$=STRING$(152,0)
1120 P!=PEEK(VARPTR(M$)+1) + 256*PEEK(VARPTR(M$)+2)
1130 IF P!>32767 THEN P!=P!-65536
1140 P=P!
1150 FOR X=1 TO 152: PRINT@141,152-X;
1160 READ Q: POKE P,Q: P=P+1: NEXT
1170 DATA 205,127, 10,243,235,221, 33,  0,  0,221
1180 DATA  25,221, 78,  0,221, 70,  1,221, 35,221
1190 DATA  35, 17,  8,  0,217, 62,  4,  8,221,102
1200 DATA   0,221,110,  1,221, 78,  2,221, 70,  3
1210 DATA 221, 94,  4,221, 86,  5, 62,  6, 60,185
1220 DATA  48, 72,187, 56, 28,121,147, 79,125,147
1230 DATA 111,221, 94,  4, 62,  2, 21, 32, 14,  8
1240 DATA 221,174,  7,211,255,  8,221, 86,  5, 62
1250 DATA   5, 24,  4, 60,185, 48, 37,189, 56,214
1260 DATA 121,149, 79,123,149, 95,221,110,  1, 62
1270 DATA   2, 37, 32,200,217,221, 25, 11,120,177
1280 DATA 200,217,  6,  1, 22,  1,221,102,  0,221
1290 DATA 110,  1, 24,178,123,145, 95,125,145,111
1300 DATA 221, 78,  2, 62,  3,  5, 32,170,  8,221
1310 DATA 174,  6,211,255,  8,221, 70,  3, 62,  5
```

Listing 1 continues

TRS-80* Model III/I

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Listing 1 continued

```
1320 DATA  24,156
1330 DIM N$(12),N(12)
1340 FOR F=0 TO 12: READ N$(F),N(F): NEXT
1350 DATA R,255,B,50,A#,53,A,56,G#,59,G,63,F#,67,F,71,E,75
1360 DATA D#,79,D,84,C#,89,C,94
1370 PRINT:PRINT"ALLOCATING MEMORY"
1380 M=MEM/12-100
1390 DIM T(M),B(M),D(4*M)
1400 BF=0: T(0)=0: B(0)=0: TD=0: BD=0: TE=0: TF=0: BE=0: BF=0
1410 F$="": EM=0: L=0: D=0: E=0: N=0: T=0: B=0: M!=0
1420 C1=255: C2=256: C3=3840: C4=192: C5=4096
1430 '
1440 '**** MAIN MENU
1450 CLS
1460 PRINT"DUAL-VOICE MUSIC MAIN MENU"
1470 PRINT
1480 PRINT"<1> LOAD MUSIC FILE"
1490 PRINT"<2> SAVE MUSIC FILE"
1500 PRINT"<3> EDIT MUSIC"
1510 PRINT"<4> BUILD PLAY BUFFER"
1520 PRINT"<5> CHANGE TIMING"
1530 PRINT"<6> PLAY MUSIC"
1540 PRINT
1550 M=0: INPUT"SELECTION";M
1560 IF M<1 OR M>6 THEN 1550
1570 IF M=4 AND (T(0)=0 OR B(0)=0) THEN PRINT E1$: GOTO 1550
1580 IF M>=5 AND BF=0 THEN PRINT E2$: GOTO 1550
1590 ON M GOSUB 1630,1870,2100,3190,3520,3600
1600 GOTO 1450
1610 '
1620 '**** LOAD MUSIC FILE
1630 CLS
1640 BF=0
1650 PRINT"<1> LOAD FROM DISK"
1660 PRINT"<2> LOAD FROM CASSETTE"
1670 PRINT"<3> LOAD FROM CASSETTE WITH DISK BASIC"
1680 PRINT
1690 M=0: INPUT"SELECTION";M
1700 IF M<1 OR M>3 THEN 1690
1710 ON M GOSUB 1730,1810,1800
1720 RETURN
1730 INPUT"MUSIC FILE SPEC";F$
1740 OPEN"I",1,F$
1750 INPUT#1,T(0),B(0)
1760 IF T(0)>0 THEN FOR X=1 TO T(0): INPUT#1,T(X): NEXT
1770 IF B(0)>0 THEN FOR X=1 TO B(0): INPUT#1,B(X): NEXT
1780 CLOSE
1790 RETURN
1800 CMD"T"
1810 INPUT#-1,T(0),B(0)
1820 IF T(0)>0 THEN FOR X=1 TO T(0): INPUT#-1,T(X): NEXT
1830 IF B(0)>0 THEN FOR X=1 TO B(0): INPUT#-1,B(X): NEXT
1840 RETURN
1850 '
1860 '**** SAVE MUSIC FILE
1870 CLS
1880 PRINT"<1> SAVE TO DISK"
1890 PRINT"<2> SAVE TO CASSETTE"
1900 PRINT"<3> SAVE TO CASSETTE WITH DISK BASIC"
1910 PRINT
1920 M=0:INPUT"SELECTION";M
1930 IF M<1 OR M>3 THEN 1920
1940 ON M GOSUB 1960,2040,2030
1950 RETURN
1960 INPUT"MUSIC FILE SPEC";F$
1970 OPEN"O",1,F$
1980 PRINT#1,T(0),B(0)
1990 IF T(0)>0 THEN FOR X=1 TO T(0): PRINT#1,T(X): NEXT
2000 IF B(0)>0 THEN FOR X=1 TO B(0): PRINT#1,B(X): NEXT
2010 CLOSE
2020 RETURN
2030 CMD"T"
2040 PRINT#-1,T(0),B(0)
2050 IF T(0)>0 THEN FOR X=1 TO T(0): PRINT#-1,T(X): NEXT
2060 IF B(0)>0 THEN FOR X=1 TO B(0): PRINT#-1,B(X): NEXT
2070 RETURN
2080 '
2090 '**** EDIT MUSIC
2100 EM=0
2110 CLS: PRINT"DUAL-VOICE MUSIC EDITOR"
2120 IF EM=0 THEN PRINT"TREBLE:";T(0); ELSE PRINT"BASE:";B(0);
2130 PRINT"NOTES"
2140 PRINT
2150 PRINT"<0> TOGGLE TREBLE/BASE"
2160 PRINT"<1> APPEND TO END OF LIST"
2170 PRINT"<2> INSERT NOTES"
2180 PRINT"<3> DELETE NOTES"
```

Listing 1 continues

options—the main menu and the edit menu. The main menu has six options:

```
Dual-Voice Music Main Menu
(1) Load Music File
(2) Save Music File
(3) Edit Music
(4) Build Play Buffer
(5) Change Timing
(6) Play Music
```

Option 1 loads the treble and bass lists of a previously created music file from either cassette or disk to memory. Option 2 saves the treble and bass lists currently in memory to cassette or disk. Option 3 calls the edit menu to create or change music in memory. Option 4 builds a play buffer from the treble and bass lists in memory. Option 5 changes the timing of the play buffer. Option 6 calls the USR subroutine to play the music.

Option 3 of the main menu calls the edit menu:

```
Dual-Voice Music Editor
Treble: XXX Notes
(0) Toggle Treble/Bass
(1) Append to End of List
(2) Insert Notes
(3) Delete Notes
(4) Display Notes
(5) Print Notes
(6) Exit
```

The second line of the edit menu displays the current number of notes in the treble or bass list. Option 0 switches back and forth between the two lists. Options 1–5 act on the list currently selected. Option 1 adds notes to the end of a list or starts a new list. Option 2 inserts notes at the start or in the middle of an existing list. Option 3 deletes one note or a block of notes. Option 4 displays the note list on the screen. Option 5 prints the note list on a line printer, formatted in multiple columns. Option 6 exits back to the main menu.

Creating the Note Lists

When appending or inserting notes, follow the format of duration, octave-note as in 4,5F#. This means quarter-note duration, 5th octave and F sharp. Durations range from 1, for a whole note, to 64, for a 64th note. Octaves range from 1, for the lowest pitch, to 5, for the highest pitch. Notes are A–G with an optional #. To enter a rest, type the duration and then R as in 8,R. This means an 8th note rest. The range of notes is from 1C to 5B. To terminate the list, enter 0,0.

Listing 1 continued

```
2190 PRINT"<4> DISPLAY NOTES"
2200 PRINT"<5> PRINT NOTES"
2210 PRINT"<6> EXIT"
2220 PRINT
2230 M=-1: INPUT"SELECTION";M
2240 IF M=6 THEN RETURN
2250 IF M=0 THEN EM=1-EM: GOTO 2110
2260 IF M<1 OR M>5 THEN 2230
2270 IF EM=0 THEN L=T(0) ELSE L=B(0)
2280 IF M>=2 AND M<=6 AND L=0 THEN PRINT E3$: GOTO 2230
2290 ON M GOSUB 2330,2540,2750,2860,3000
2300 GOTO 2110
2310 '
2320 '**** APPEND NOTES
2330 CLS
2340 PRINT"APPENDING ";
2350 IF EM=0 THEN PRINT"TREBLE"; ELSE PRINT"BASE";
2360 PRINT" NOTES"
2370 PRINT
2380 PRINT"DURATION,NOTE"
2390 L=L+1
2400 PRINT USING "####:";L;
2410 D=-1: INPUT D,F$: IF D=0 THEN RETURN
2420 IF F$="R" THEN E=0: F=0: GOTO 2480
2430 IF LEN(F$)<2 THEN PRINT E4$: GOTO 2400
2440 E=VAL(LEFT$(F$,1)): IF E<1 OR E>5 THEN PRINT E5$: GOTO2400
2450 F=1: F$=MID$(F$,2)
2460 IF F$<>N$(F) THEN F=F+1: IF F<13 THEN 2460
2470 IF F>12 THEN PRINT E4$: GOTO 2400
2480 IF EM=0 THEN T(0)=L ELSE B(0)=L
2490 P=4096*E + 256*F + D
2500 IF EM=0 THEN T(L)=P ELSE B(L)=P
2510 BF=0: GOTO 2390
2520 '
2530 '**** INSERT NOTES
2540 CLS
2550 N=0: INPUT"INSERT BEFORE WHICH NOTE";N
2560 IF N<1 OR N>L THEN 2550
2570 PRINT"DURATION,NOTE"
2580 PRINT USING "####:";N;
2590 D=-1: INPUT D,F$: IF D=0 THEN RETURN
```

Listing 1 continues

The editor numbers all the notes. Use these numbers to refer to the notes when deleting or inserting. Enter the starting and ending note numbers to delete a series of notes. The starting and ending numbers would be the same number if you wanted to delete only one note. To insert notes, enter the number following the insert point; this allows insertion before the first note. Use the append option to insert notes at the end of the list.

To replace one or more notes, first delete them and then insert the replacements. The editor controls the numbers so that the first note number you delete becomes the note number to insert. For example, if you want to replace notes 33–40, select the delete option and enter 33,40. Then select the insert option and enter 33 as the insert point. Type the replacement notes and then 0,0.

The display option lists the notes on the screen in a single column. To freeze the list as it scrolls by, press shift, @. Press any key to resume scrolling.

If you have a printer connected to the parallel printer port, select the print option to produce a multiple-column listing of the notes. Each column is 16 characters wide. This permits five columns on an 80-character-per-line print-

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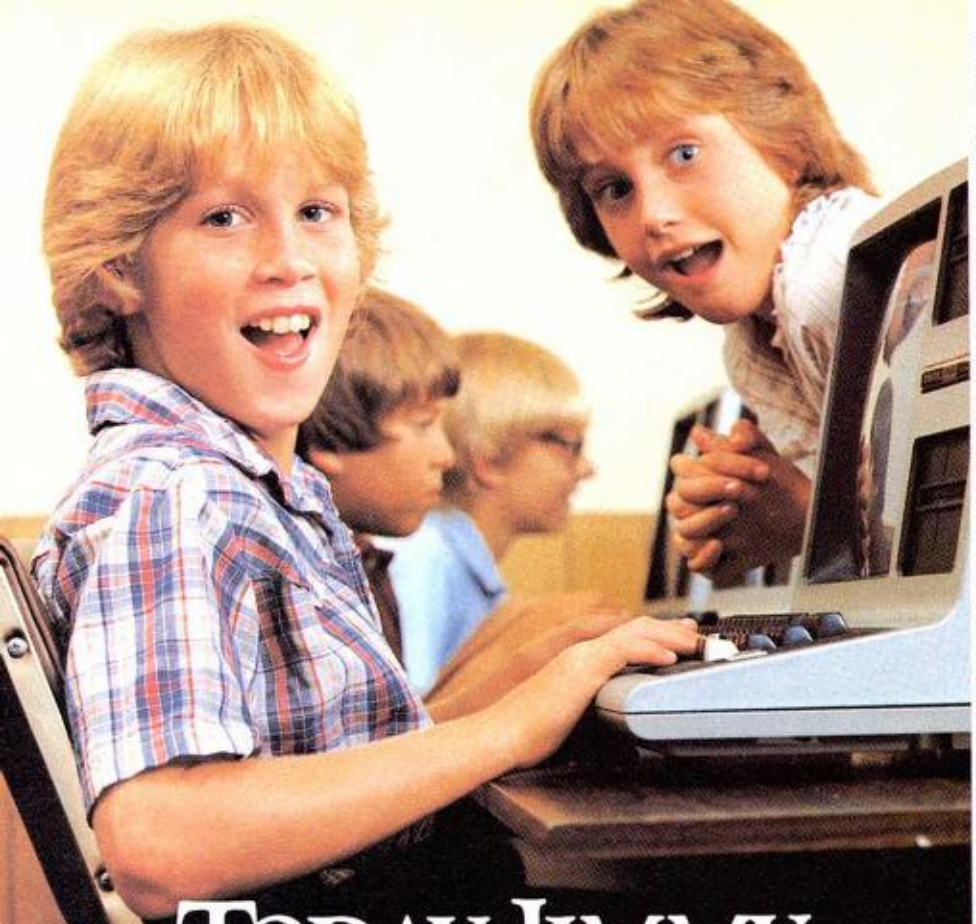

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Playing the Music

Before playing the piece, you must select the build-play-buffer option. This option creates a combined buffer from the treble or bass lists so the USR subroutine can efficiently create the dual-voice melodies. Once you have built the play buffer, you can play the music repeatedly without delay.

The musical piece can be played in two ways. The best way is to connect an amplifier and speaker to the auxiliary output of the cassette port. The extra hardware is not necessary for the second method. Just connect your cassette recorder in the standard way, set the cassette to record, select the play-music option, wait for the main menu to reappear on the screen, stop the recorder, rewind to the start point, unplug the cables, and press the cassette play button.

If the piece plays too fast or too slow, select the change-timing option. Enter a multiplier for the duration. Enter 2 if you want the piece to play slower, or enter 0.5 if you want the piece to play faster. The multiplier acts only on the play buffer, so the original treble and

Listing 1 continued

```
2600 IF F$="R" THEN E=0: F=0: GOTO 2660
2610 IF LEN(F$)<2 THEN PRINT E4$: GOTO 2580
2620 E=VAL(LEFT$(F$,1)): IF E<1 OR E>5 THEN PRINT E5$: GOTO2580
2630 F=1: F$=MID$(F$,2)
2640 IF F$<>N$(F) THEN F=F+1: IF F<13 THEN 2640
2650 IF F>12 THEN PRINT E4$: GOTO 2580
2660 IF EM=0 THEN T(0)=T(0)+1 ELSE B(0)=B(0)+1
2670 FOR X=L TO N STEP -1
2680 IF EM=0 THEN T(X+1)=T(X) ELSE B(X+1)=B(X)
2690 NEXT X
2700 P=4096*E + 256*F + D
2710 IF EM=0 THEN T(N)=P ELSE B(N)=P
2720 BF=0: L=L+1: N=N+1: GOTO 2580
2730 '
2740 '**** DELETE NOTES
2750 CLS
2760 P=0: Q=0: INPUT"DELETE FROM,TO";P,Q
2770 IF P<1 OR P>Q OR Q>L THEN 2760
2780 IF EM=0 THEN T(0)=T(0)-(Q-P+1) ELSE B(0)=B(0)-(Q-P+1)
2790 BF=0
2800 IF Q=L THEN RETURN
2810 FOR X=Q+1 TO L
2820 IF EM=0 THEN T(P)=T(X) ELSE B(P)=B(X)
2830 P=P+1: NEXT X: RETURN
2840 '
2850 '**** DISPLAY NOTES
2860 CLS
2870 IF EM=0 THEN PRINT"TREBLE" ELSE PRINT"BASE"
2880 PRINT
2890 PRINT"   DURATION,NOTE"
2900 FOR X=1 TO L: PRINT USING "####:";X;
2910 IF EM=0 THEN D=T(X) AND 255 ELSE D=B(X) AND 255
2920 IF EM=0 THEN E=T(X)/4096 ELSE E=B(X)/4096
2930 IF EM=0 THEN F=(T(X) AND 3840)/256
             ELSE F=(B(X) AND 3840)/256
2940 F$=N$(F)
2950 IF E>0 THEN PRINT USING "#####  #%% ";D;E;F$
             ELSE PRINT USING "#####   %% ";D;F$
2960 NEXT X
2970 PRINT: INPUT"PRESS ENTER";M: RETURN
2980 '
```

Listing 1 continues

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Listing 1 continued

```
2990 '**** PRINT NOTES
3000 CLS
3010 M=0: INPUT"PRINT HOW MANY COLUMNS";M
3020 IF M<1 THEN 3010
3030 LPRINT:LPRINT
3040 IF EM=0 THEN LPRINT"TREBLE" ELSE LPRINT"BASE"
3050 LPRINT
3060 FOR X=1 TO M: LPRINT"   DURATION,NOTE";: NEXT
3070 LPRINT
3080 P!=L/M: Q=L/M: IF P!>Q THEN Q=Q+1
3090 FOR X=1 TO Q
3100 FOR N=0 TO M-1: P=X+N*Q: IF P>L THEN 3160
3110 IF EM=0 THEN D=T(P) AND 255 ELSE D=B(P) AND 255
3120 IF EM=0 THEN E=T(P)/4096 ELSE E=B(P)/4096
3130 IF EM=0 THEN F=(T(P) AND 3840)/256
             ELSE F=(B(P) AND 3840)/256
3140 F$=N$(F)
3150 IF E>0 THEN LPRINT USING "####:#####  ### ";P;D;E;F$;
          ELSE LPRINT USING "####:#####   ## ";P;D;F$;
3160 NEXT N: LPRINT: NEXT X: RETURN
3170 '
3180 '**** BUILD PLAY BUFFER
3190 CLS
3200 PRINT"BUILDING PLAY BUFFER":PRINT
3210 PRINT"","TREBLE","BASE"
3220 PRINT "LENGTH",T(0),B(0)
3230 T=1: B=1: X=1: GOSUB 3440: GOSUB 3480
3240 D(X+1)=C2*2[(5-TE) + N(TF)
3250 D(X+2)=C2*2[(5-BE) + N(BF)
3260 D(X+3)=(P AND 2) + C2*(Q AND 1)
3270 PRINT@256,,T,B
3280 IF TD>=BD THEN 3320
3290 D(X)=TD: T=T+1: BD=BD-TD
3300 IF T<=T(0) THEN GOSUB 3440
3310 GOTO 3390
3320 IF TD=BD THEN 3360
3330 D(X)=BD: B=B+1: TD=TD-BD
3340 IF B<=B(0) THEN GOSUB 3480
3350 GOTO 3390
3360 D(X)=BD: B=B+1: T=T+1
```

Listing 1 continues

bass lists are not affected.

Understanding the Program

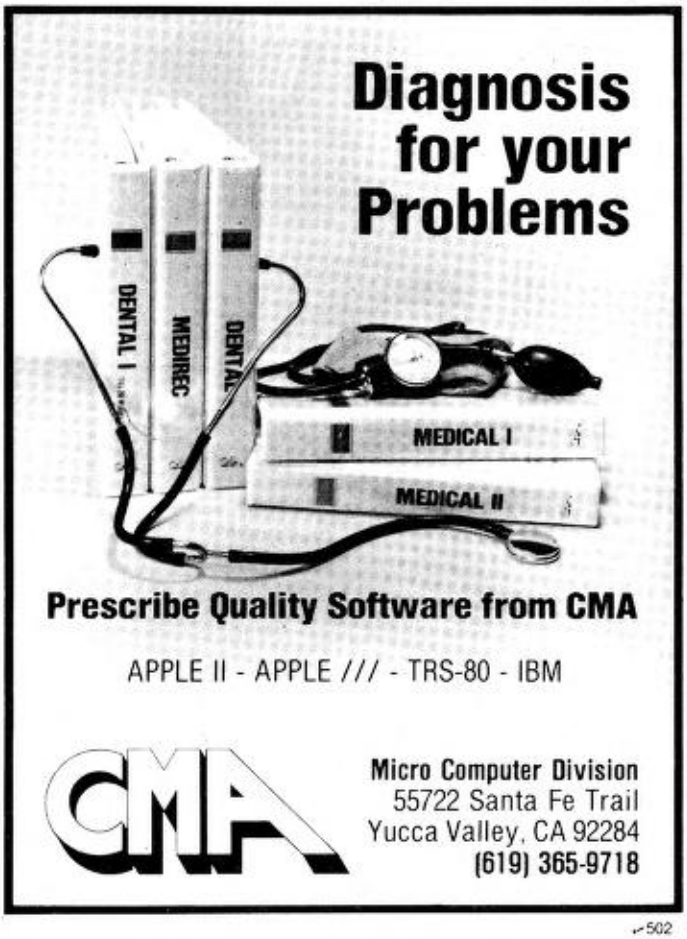
The most important variables in the Basic program, together with their meanings, are listed in Table 2.

The parameters for each treble or bass note are packed into one integer by the formula: 4096 * octave + 256 * note + duration. Figure 2 shows this format.

The play buffer consists of a note count followed by 8-byte entries. The format for each entry is shown in Table 3. Each note change has a new entry.

The USR subroutine reads the play buffer to produce the tones. Listing 2 is an Assembly-language form of the USR subroutine. Line 130 gets the play buffer address. Lines 160–170 transfer this address into the IX register. The A' register maintains the current tone command value. Lines 330–370 and 580–620 count the treble, bass, and note duration values until one of them becomes due.

When the treble count becomes due, lines 890–980 reload the count and continue timing. When the treble octave count becomes due, lines 990–1050 change the tone level command value and resend the command. Lines



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400–560 update the bass note counts in the same way.

When the duration count becomes due, lines 750–860 advance IX to point to the next note entry in the play buffer, terminate the treble and bass octave counts, and continue timing, allowing the treble and bass timers to complete the current cycle. Control returns to Basic when all notes have been played.

Enhancing the Program

There are many ways to improve the program. Adding more editing features would make it easier to enter and modify the music—or including a subroutine facility would make it possible to play longer pieces. The greatest improvement, however, would be a hardware change.

The TRS-80 clock is not fast enough to produce the high quality of sound that best enhances the dual-voice technique. Speeding it up would make the timing of each note more accurate and would enable the program to generate higher-quality notes and increase the range of tones.

This program is just one method for dual-voice synthesis. Another example is synthesizing voices out of the cassette port. With new innovations and experi-

Listing 1 continued

```
3370 IF T<=T(0) THEN GOSUB 3440
3380 IF B<=B(0) THEN GOSUB 3480
3390 D(X)=D(X)-C2: X=X+4
3400 IF T<=T(0) AND B<=B(0) THEN 3240
3410 D(0)=X/4: BF=-1: RETURN
3420 '
3430 '**** COMPUTE TREBLE PLAY BUFFER ENTRY
3440 TD=C4/(T(T) AND C1): TE=T(T)/C5
3450 TF=(T(T) AND C3)/C2: P=TF>0: RETURN
3460 '
3470 '**** COMPUTE BASE PLAY BUFFER ENTRY
3480 BD=C4/(B(B) AND C1): BE=B(B)/C5
3490 BF=(B(B) AND C3)/C2: Q=BF>0: RETURN
3500 '
3510 '**** CHANGE TIMING
3520 CLS
3530 M!=1: INPUT"TIMING MULTIPLIER";M!
3540 FOR X=1 TO D(0)*4 STEP 4
3550 D(X)=(D(X) AND 255)*M! - 256
3560 NEXT
3570 RETURN
3580 '
3590 '**** PLAY MUSIC
3600 CLS
3610 PRINT"<1> PLAY USING DISK BASIC"
3620 PRINT"<2> PLAY USING LEVEL II BASIC"
3630 PRINT
3640 M=0: INPUT"SELECTION";M
3650 IF M<1 OR M>2 THEN 3640
3660 CLS: Q=VARPTR(D(0))
3670 IF M=2 GOTO 3720
3680 P!=PEEK(VARPTR(M$)+1)+256*PEEK(VARPTR(M$)+2)
3690 IF P!>32767 THEN P!=P!-65536
3700 P=P!: DEFUSR0=P: M=USR0(Q)
3710 RETURN
3720 POKE 16526,PEEK(VARPTR(M$)+1)
3730 POKE 16527,PPEK(VARPTR(M$)+2)
3740 M=USR(Q)
3750 RETURN
3760 '
3770 'END OF PROGRAM
```


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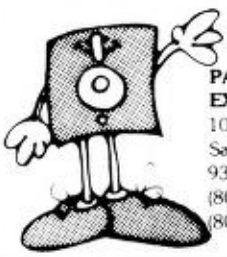

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mentation, perhaps someone will even discover a way to produce the sounds of an entire orchestra. ■

Lee Morgenstern can be reached at 14358 Dyer St., Sylmar, CA 91342.

Program Listing 2

```
                00100 ;DUAL-VOICE MUSIC USR SUBROUTINE
                00110 ; BY LEE MORGENSTERN, MAY, 1982
                00120 ;
0000 CD7F0A     00130           CALL    0A7FH           ;HL=NOTE LIST ADDRESS
0003 F3         00140           DI                      ;DISABLE INTERRUPTS
0004 EB         00150           EX      DE,HL           ;DE=NOTE LIST ADDRESS
0005 DD210000   00160           LD      IX,0            ;
0009 DD19       00170           ADD     IX,DE           ;IX=NOTE LIST ADDRESS
000B DD4E00     00180           LD      C,(IX)          ;BC=NOTE LIST LENGTH
000E DD4601     00190           LD      B,(IX+1)        ;
0011 DD23       00200           INC     IX              ;
0013 DD23       00210           INC     IX              ;
0015 110800     00220           LD      DE,8            ;NOTE LIST ENTRY LENGTH
0018 D9         00230           EXX                     ;
0019 3E04       00240           LD      A,4             ;SET CASSETTE COMMAND
001B 08         00250           EX      AF,AF'          ;SAVE TONE LEVEL
001C DD6600     00260           LD      H,(IX)          ;GET NOTE DURATION
001F DD6E01     00270           LD      L,(IX+1)        ;
0022 DD4E02     00280           LD      C,(IX+2)        ;SET TREBLE COUNTER
0025 DD4603     00290           LD      B,(IX+3)        ;SET TREBLE OCTAVE
0028 DD5E04     00300           LD      E,(IX+4)        ;SET BASE COUNTER
002B DD5605     00310           LD      D,(IX+5)        ;SET BASE OCTAVE
002E 3E06       00320 MUSIC1    LD      A,6             ;SET TIMING COUNTER
0030 3C         00330 MUSIC2    INC     A               ;UPDATE TIMING COUNTER
0031 B9         00340           CP      C               ;CHECK TREBLE DUE TIME
0032 3048       00350           JR      NC,MUSIC6       ;JUMP IF DUE
0034 BB         00360 MUSIC3    CP      E               ;CHECK BASE DUE TIME
0035 381C       00370           JR      C,MUSIC4        ;JUMP IF NOT DUE
                00380           ;
                00390           ;RELOAD BASE TIMER
0037 79         00400           LD      A,C             ;GET TREBLE TIMER
0038 93         00410           SUB     E               ;COMPUTE NEXT DUE TIME
0039 4F         00420           LD      C,A             ;
003A 7D         00430           LD      A,L             ;GET DURATION TIMER
003B 93         00440           SUB     E               ;COMPUTE NEXT DUE TIME
003C 6F         00450           LD      L,A             ;
003D DD5E04     00460           LD      E,(IX+4)        ;RELOAD BASE TIMER
0040 3E02       00470           LD      A,2             ;SET TIMING COUNTER
0042 15         00480           DEC     D               ;DECREMENT OCTAVE COUNTER
0043 200E       00490           JR      NZ,MUSIC4       ;JUMP IF NOT DONE
0045 08         00500           EX      AF,AF'          ;GET PREVIOUS TONE LEVEL
0046 DDAE07     00510           XOR     (IX+7)          ;TOGGLE BASE TONE LEVEL
0049 D3FF       00520           OUT     (255),A         ;COMMAND TONE LEVEL
004B 08         00530           EX      AF,AF'          ;SAVE TONE LEVEL
004C DD5605     00540           LD      D,(IX+5)        ;RELOAD OCTAVE COUNTER
004F 3E05       00550           LD      A,5             ;SET TIMING COUNTER
0051 1804       00560           JR      MUSIC5          ;CONTINUE
                00570           ;
0053 3C         00580 MUSIC4    INC     A               ;UPDATE TIMING COUNTER
0054 B9         00590           CP      C               ;CHECK TREBLE DUE TIME
0055 3025       00600           JR      NC,MUSIC6       ;JUMP IF TREBLE DUE
0057 BD         00610 MUSIC5    CP      L               ;CHECK NOTE DURATION
0058 38D6       00620           JR      C,MUSIC2        ;JUMP IF NOT DUE
                00630           ;
                00640           ;RELOAD NOTE DURATION TIMER
005A 79         00650           LD      A,C             ;GET TREBLE TIMER
005B 95         00660           SUB     L               ;COMPUTE NEXT DUE TIME
005C 4F         00670           LD      C,A             ;
005D 7B         00680           LD      A,E             ;GET BASE TIMER
005E 95         00690           SUB     L               ;COMPUTE NEXT DUE TIME
005F 5F         00700           LD      E,A             ;
0060 DD6E01     00710           LD      L,(IX+1)        ;RELOAD DURATION TIMER
0063 3E02       00720           LD      A,2             ;SET TIMING COUNTER
0065 25         00730           DEC     H               ;DECREMENT DURATION COUNT
0066 20C8       00740           JR      NZ,MUSIC2       ;JUMP IF NOT DONE
0068 D9         00750           EXX                     ;
0069 DD19       00760           ADD     IX,DE           ;NEXT NOTE
006B 0B         00770           DEC     BC              ;
006C 78         00780           LD      A,B             ;
006D B1         00790           OR      C               ;
006E C8         00800           RET     Z               ;RETURN IF NO MORE NOTES
006F D9         00810           EXX                     ;
0070 0601       00820           LD      B,1             ;TERMINATE TREBLE
0072 1601       00830           LD      D,1             ;TERMINATE BASE
0074 DD6600     00840           LD      H,(IX)          ;GET NEXT NOTE DURATION
0077 DD6E01     00850           LD      L,(IX+1)        ;
007A 18B2       00860           JR      MUSIC1          ;RESTART PLAY TIMING
                00870           ;
                00880           ;RELOAD TREBLE TIMER
007C 7B         00890 MUSIC6    LD      A,E             ;GET BASE TIMER
007D 91         00900           SUB     C               ;COMPUTE NEXT DUE TIME
007E 5F         00910           LD      E,A             ;
007F 7D         00920           LD      A,L             ;GET DURATION TIMER
0080 91         00930           SUB     C               ;COMPUTE NEXT DUE TIME
0081 6F         00940           LD      L,A             ;
0082 DD4E02     00950           LD      C,(IX+2)        ;RELOAD TREBLE TIMER
0085 3E03       00960           LD      A,3             ;SET TIMING COUNTER
0087 05         00970           DEC     B               ;DECREMENT OCTAVE COUNTER
0088 20AA       00980           JR      NZ,MUSIC3       ;JUMP IF NOT DONE
008A 08         00990           EX      AF,AF'          ;GET PREVIOUS TONE LEVEL
008B DDAE06     01000           XOR     (IX+6)          ;TOGGLE TREBLE TONE LEVEL
008E D3FF       01010           OUT     (255),A         ;COMMAND TONE LEVEL
0090 08         01020           EX      AF,AF'          ;SAVE TONE LEVEL
0091 DD4603     01030           LD      B,(IX+3)        ;RELOAD OCTAVE COUNTER
0094 3E05       01040           LD      A,5             ;SET TIMING COUNTER
0096 189C       01050           JR      MUSIC3          ;CONTINUE
                01060           ;
0000            01070           END
00000 TOTAL ERRORS
```

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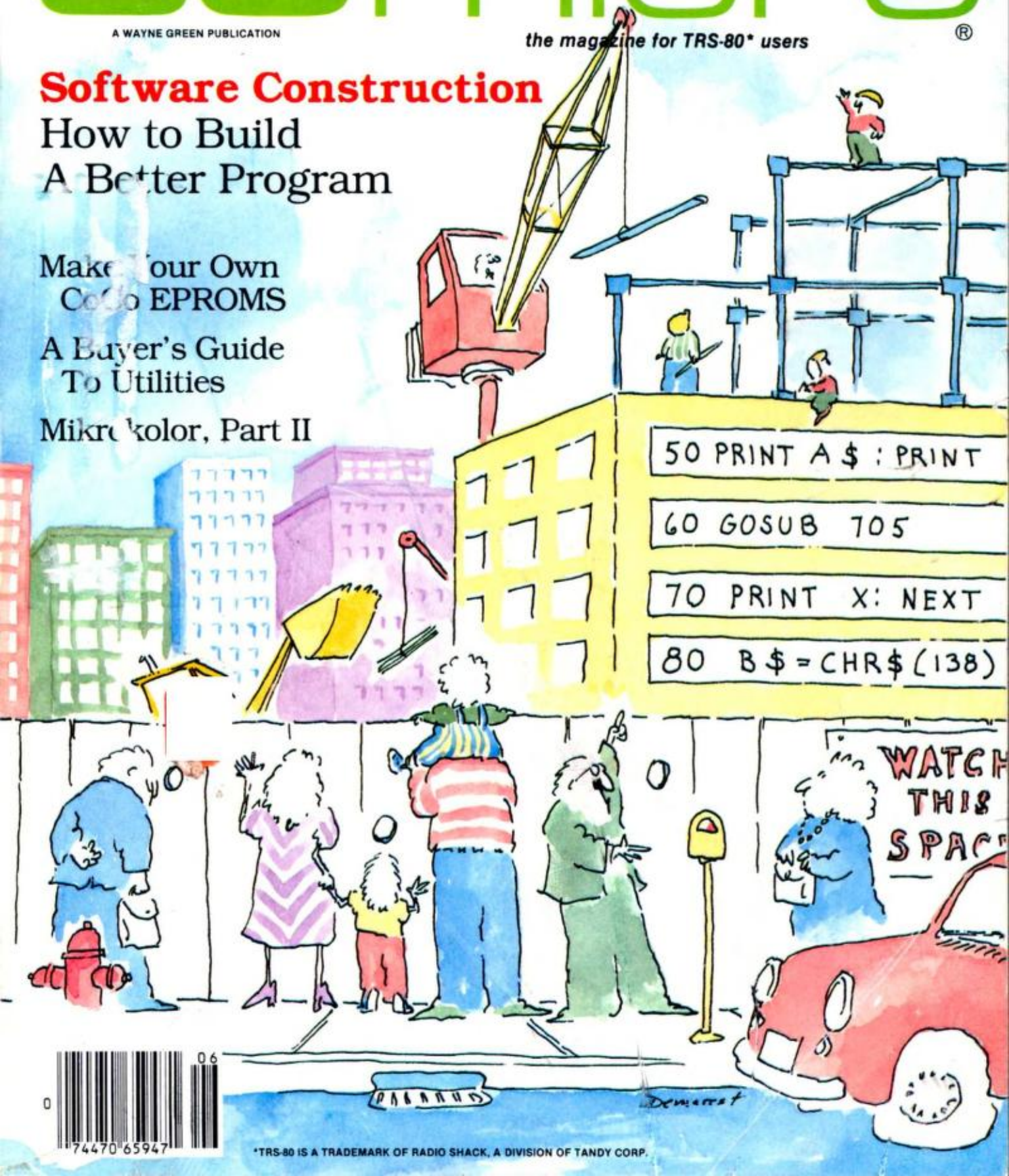

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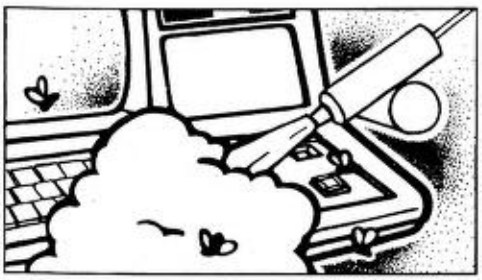
Found and Fixed

I found and fixed some bugs in my "Outbreak" program (January 1983, p. 216). Most of the problems come from the sound routine, but a bug lives in line 200. To exterminate this problem enter it as: 200 IF X>126 THEN A=−A:X=126:GOTO 170.

If you own a tape system and are having problems with the sound routine, change Z1=127 to Z1=126 in line 700, or set the memory size to 32000. The sound is improved by changing all the USR(12)'s to USR(0)'s.

If you own a disk system and are having sound routine problems, you should change line 700 to: 700 DEFUSR0=32000: Z=32000. You should also change all JJ=USR(12)'s to JJ=USR(0)'s.

Tom Hanson
2120 Birchmont Drive
Bemidji, MN 56601



Patches and fixes

Our Fault

The following program (see Listing 1) was left out of Steven M. Groll's "The 2,000-Year-Old Algorithm" article (March 1983, p. 332). The line numbers mentioned in the first column on p. 333 refer to this program listing.—*Eds.*

Program Listing 1

```
9000 GOSUB9990
9010 PRINT"HOW MANY NUMBERS TO BE INPUT?"
9015 INPUT"(10 OR LESS)";F
9020 IFF>10 THEN 9000
9030 PRINT:PRINT"*NUMBERS MUST BE INPUT IN"
9040 PRINT"ORDER FROM SMALLEST TO LARGEST *"
9042 PRINT"*ALL NUMBERS MUST BE SMALLER"
9043 PRINT"THAN 1,000,000*"
9045 FORG=1TOF
9050 PRINT:PRINT"INPUT #";G;":";
9060 INPUTM(G)
9065 IFM(G)>999999THEN 9000
9070 IFG>=2THEN 9100      'YOU NEED AT LEAST 2 TO COMPARE
9080 NEXT
9090 GOTO9190
9100 IFM(G)>M(G-1)THEN 9080      'MAKE SURE NUMBERS IN ORDER
9110 GOSUB9990:PRINT"THE NUMBERS MUST BE INPUT IN"
9120 PRINT"ORDER FROM SMALLEST TO LARGEST"
9130 FORX=1TO 2000:NEXT:GOSUB9990
9140 GOTO9045
9190 CLS
9200 FORG=1TOF-1
9210 Q=INT(M(G+1)/M(G))          'Q=QUOTIENT
9220 R=M(G+1)-(M(G)*Q)           'R=REMAINDER
9230 IFR=0THEN 9300
9240 M(G+1)=M(G):M(G)=R       'REASSIGN VALUES
9260 GOTO9210
9300 IFG=F-1THEN 9400         'LAST ONE?
9305 M(G+1)=M(G)     'OLD DIVISOR BECOMES NEW DIVIDEND
9310 NEXT
9400 GOSUB9990:PRINT"GCD = ";M(G)
9500 PRINT:PRINT:PRINT:PRINT"DO YOU WISH TO CONTINUE?"
9505 PRINT"Y=YES  N=NO)"
9510 INPUTA$:IFA$="Y"THEN9000ELSEEND
9990 CLS:PRINTCHR$(23):RETURN
10050 ' ----------------------
10060 '   EUCLIDEAN ALGORITHM
10070 '   COMPLETED   5/19/81
10080 '     STEVEN M. GROLL
```

The Judge's Decision

Figure 1 in my "Judge 80" article (January 1983, p. 221) is incorrect. The correct pinouts to IC4 are, from top to bottom:

IN	OUT
3	4
1	2
13	12
5	6
11	10
9	8

Also, the correct identification for IC2 in the IC list is:

IC1,2	74LS367
IC3	74LS08
IC4	74LS04

Stuart A. Cole
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Directory Patches

Although the code in Carl Anderson's "Easier Directory" (December 1982, p. 32) assembled with no errors, the program produces nondescript garbage. The problem is not with the code, but with TRSDOS 1.3. Radio Shack released TRSDOS 1.3 with several errors and then published patches for some of them in the October 1981 issue of *TRS-80 Microcomputer News*. The problem is found in the I/O call to display the directory. The following two patches correct this anomalous I/O call.

PATCH * 10 (ADD=4E2E, FIND=CD3E4B, CHG=CD8A50)
PATCH * 10 (ADD=508A, FIND=4469736B, CHG=4FC33E4B)

James A. Calloway
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Ruston, LA 71270

Better Music

The "Dual-Voice Music Synthesizer" by Lee Morgenstern (1983 Anniversary Issue, p. 253) bombs on the Model I with an OV error at line 1160. To correct this, change line 1160 to read: 1160 READ Q:POKE X−1+P,Q:NEXT and

change line 1030 to: 1030 CLS:CLEAR 500:DEFINT A–Z.

After doing this, insert line 1055 which reads: 1055 M$ = STRING$ (152,0). Line 1055 is exactly the same as line 1110, but don't delete line 1110. This changes the starting address of M$ to 32464 instead of 32616.

Paul F. Smith
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Hatboro, PA 19040

Fire One!

I found an error in David Edick's "Space Duel" program for the Model III (August 1982, p. 260). To let your spaceship fire, change line 123 to: IF A$ = "C" THEN 1000.

Mari Ascolese
115 Ave Maria
San Antonio, TX 78216

Sorting Problem O.K.

There's an error in Bill Barden's "Assembly-Language Primer" program listing (1983 Anniversary Issue, p. 16) that prevents the last element from being sorted. The eighth data element in line 101 of Program Listing 3 should be changed from 254 to 255.—*Eds.*

Turtle Problems

Larry Brackney's "TRS-Turtle" program (February 1983, p. 116) has a bug under its shell. To get rid of it, change line 250 to: 250 L$(W) = B:W = W + 1:T$ = B.—*Eds.*

It's an Arrow!

There's a typo in the correction to Delmer Hinrichs' "Practical Regression Analysis" program in the February 1983 Debug column (p. 30). In line 2830, between the DZ and 3 there should be an up-arrow instead of a parenthesis. Otherwise it is correct.

Oh, well. You know what they say: "...and these bugs have smaller bugs upon their backs to byte them...."—*Eds.*

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