

creative computing

July 1980
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8 Columns, 3 Evaluations, 10 Columns, 16 Articles

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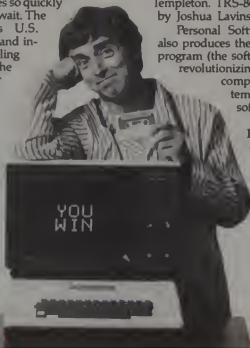
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The Cover

The painting by Charles Vase depicts the conflict and dilemma of many adventure type games. The dragon is protecting the hoard of gold under the greasy knoll while the wizard (you and the computer) tries to retrieve it. (See pages 95-98).

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Corrections

Computing Trash To Treasure (May) omitted the following listings under the heading *Some Refund Publications*:

Cash Flash, Coupon Saving House, P.O. Box 46577, Dept. JM, Hollywood, CA 90046. Ed. Lynda Bettenhausen, Sample \$1.50, 6 mo. \$8; year, \$12.

Firefly Reporter, Box 263, Dept. JM, Fulda, MN 56131. Ed. Isabelle Welch, sample \$1; 3 issues \$3; 6 issues \$5, year \$9.

T-Ms No Form Needed Round-Up, Box 783, Dept. JM, Republic, PA 15475. Ed. Rosemary A. Mehali, single issue \$2, 4 issues \$7.

In our April issue, the top line of Figure 2 in Howard Bergenbon's "Word Board" should read as follows:

1=1 2=2 3=3 4=4 5=5 6=6 7=7 8=8 9=9 0=0

Here's the missing program from Three Dimensional Graphics, page 129, June issue.

```

10 REM *THREE DIMENSIONAL PLOTTING BY CHRIS KING*
20 REM
30 REM *INITIALIZE ALL VARIABLES
40 PRINT "ROTATION, ELEVATION"
50 INPUT T,A
60 PRINT "ORIGIN OF VIEWING (X,Y,Z)"
70 INPUT P1,P2,P3
80 PRINT "FIELD OF VIEW"
90 INPUT F
100 T=0:1.74533E-2 '(DEGREES TO RADIANS)'
110 A=0:1.74533E-2
120 REM *AUTO ORIGIN OF CUBE
130 B=ABS(SIN(T)*COS(T))
140 B=COS(T)*COS(T)*SIN(A)+SIN(T)*SIN(A)+SIN(COS(A))
150 REM *POINT OF VIEW ON CARTESIAN PLANE
160 P4=0:1-(P1-5)*SIN(T)*COS(T)+P2-5)*COS(T)
170 P5=0:1-(P1-5)*SIN(T)*COS(T)+P2-5)*SIN(T)+P3-5)*COS(A)
180 REM *S-SCALING FACTOR
190 S=10000/17.5 '10000=SIZE OF PLOTTER DOT MATRIX'
200 REM *SCAN ALL Y LINES
210 FOR Y1=0 TO 10
220 PRINT "PLT" 'POSITION BEGINNING OF LINE (PLOT POINT)'
230 FOR Y1=0 TO 10.25 'QUARTER SQUARE INCREMENTS'
240 GOSUB 400
250 IF Y1<0 THEN 270
260 PRINT "PLT" 'START PLOTTING LINE'
270 NEXT Y1
280 NEXT X1
290 REM *SCAN ALL X LINES
300 FOR Y1=0 TO 10
310 PRINT "PLT"
320 FOR X1=0 TO 10.25
330 GOSUB 400
340 IF X1<0 THEN 360
350 PRINT "PLT"
360 NEXT X1
370 NEXT Y1
380 PRINT "PLT"
390 STOP
400 CALL FNC3D 'DEFINE Z1=...'
410 IF Z1=0 THEN 430
420 Z1=0
430 IF Z1=0 THEN 450
440 Z1=10
450 X2=0:1-(X1-5)*SIN(T)+(Y1-5)*COS(T)
460 Y2=0:1-(X1-5)*COS(T)+(Y1-5)*SIN(T)+(Z1-5)*COS(A)
470 Z2=COS(A)+(P1-X1)*COS(T)+(P2-Y1)*SIN(T)+(P3-Z1)*SIN(A)
480 IF D=0 THEN 520
490 X3=(X2-P4)/(P4-D+1)+P4
500 Y3=(Y2-P5)/(P5-D+1)+P5
510 PRINT INT(X3*5):INT(Y3*5)
520 RETURN
530 END

```

LOCAL Program Services Available

Project LOCAL of Westwood, Mass. announces the LOCAL Associate Member Program (LAMP) to extend its computer-oriented education services beyond the area previously served. LOCAL has been successfully helping schools in the Boston area to teach with and about computers for over a decade. LOCAL works on the premise that it makes good sense to pool instructional computing expertise and resources, and to share them among schools.

Starting July 1, 1980, various services will be provided to any school system for a flat annual fee of \$750 (\$650 if the system registers before August 15). This sum could be saved easily just by taking advantage of one or two services.

For more information or registration forms contact Project LOCAL, 200 Nahatan Street, Westwood, MA 02090. (617) 326-3050.

Seventh Annual National Computer Education Institute

Jointly sponsored by Central State University of Oklahoma, the University of Massachusetts, and *Interlace: The Computer Education Quarterly Journal*, two institute locations will be offered to college and high school teachers this summer. This year's new program offers the choice of two locations and dates, and a choice of five fully credited college courses. Past enrollment has been cut off at one hundred persons. The new program will double that capacity, but enrollment will still be on a first-come basis.

The first session will take place June 8th through June 20 at the Amherst, Massachusetts campus; the second session August 3rd-15th at the Edmond, Oklahoma campus.

Although there is slight variation between campuses in costs, registration fees are \$100; tuition about \$125. Meals and dormitory housing are provided at \$145 to \$225 for the two-week program.

Detailed course outlines and registration information is available from Dr. Joe M. Kinzer, Central State University, Edmond, Oklahoma, 73034, (405) 341-2980 ext. 741.

Call For Papers

Papers are being solicited for the 1981 Summer Computer Simulation Conference to be held July 21-23, 1981, in Washington, D.C. The conference theme is "Simulation: Foundations and the Future." Accepted papers will be published in bound Proceedings distributed at the Conference. Five hundred word summaries or complete drafts of original papers must be submitted by November 15, 1980 to: L. O. Culhane, The MITRE Corporation, 1820 Dolley Madison Blvd., McLean, VA 22102, (703) 827-8447.

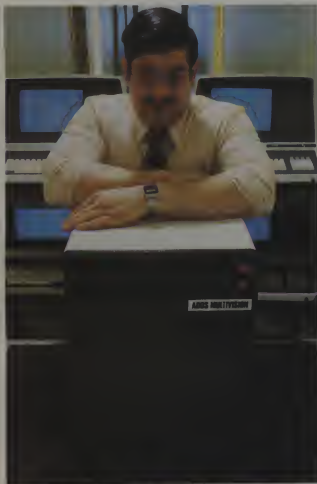
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CIRCLE 108 ON READER SERVICE CARD

Input/ Output

Continuing Chess Feedback

Dear Editor:

I read with interest the letters concerning computer chess in Input/Output of the February issue. I can only add a hearty second to the advice given by Mr. Kimmel to those with apparent problems in a chess computer they have purchased. If the customer will follow the steps outlined by Mr. Kimmel, any malfunction can be quickly corrected. Our Customer Service department is contacting Mr. Glass in order to insure that his Boris is in perfect working order.

Mr. Goldman's five move mate against Micro-Chess was very interesting, but I wonder if any of your readers have managed to play very short games against the new generation of chess computers now available. Is it possible to defeat these stronger units at their "tournament levels" quickly? And what about one machine stomping another? Enclosed is a copy of a game in which Sargon 2.5, playing on the Chafitz Modular Game System, mated the Voice Chess Challenger in 14 moves. One interesting aspect of this game is that Sargon 2.5 repeatedly passed up opportunities to capture material in order to press forward with the attack.

WHITE	BLACK	WHITE	BLACK
1 E2 - E4	C7 - C5	8 E1 - C1	D8 - C7
2 G1 - F3	E7 - E6	9 F1 - B5	C7 - D8
3 D2 - D4	C5 x D4	10 B5 x D7	D8 - C7
4 F3 x D4	B8 - C6	11 D4 - C4+	F8 x C5
5 C1 - E3	D8 - A5+	12 C3 - B5+	C7 - B8
6 B1 - C3	C6 x D4	13 E3 - F4+	E6 - E5
7 D1 x C3	E8 - D8	14 F4 x E5+	E6 - E5
		14 Mate in 1	I LOSE

(If your readers want to reproduce this game, they should be aware that the Voice plays a somewhat randomized game so it will not always play this exact game. But entering "C1" will force it to play this opening and then it will usually complete the game as described. Sargon 2.5 when put in the "BEST" mode is not randomized and therefore will always play this game once he is out of opening book. While in book, Sargon plays the various openings in about the same proportions that they are played by masters, and since this opening is a common one, Sargon 2.5 will play it often. If he plays another opening, the "RESTORE" key can be used to "take back" the opening moves and try again.)

Perhaps Creative Computing could sponsor an informal contest to see who could submit the shortest computer vs. computer game played on tournament levels.

Dan Neumayer,
Product Development Manager
Chafitz
1055 First Street
Rockville, MD 20850

Dear Editor:



Mr. Neumayer's letter confirms the preliminary reports we have heard about the strength of Boris/Sargon 2.5. The program finished seventh in the ACM's Tenth North American Computer Chess Championship, against such heavyweight competition as Chess 4.9 (which won), Belle and Duchess. David Kittinger's Mychess came in sixth. Now if we could just persuade Mr. Neumayer and Mr. Kittinger to loan us copies of their products for the Second Annual Creative Computing Microcomputer Chess Tournament...

All right... An informal contest. Submit the shortest game against one of the stronger machines or programs... either by a human or another machine and win a copy of Kimmel's chess program. Second place wins two copies.

Programmers and manufacturers are encouraged to submit their products to Contributing Editor Stephen Kimmel at 4756 S. Irvington Place, Tulsa, OK 74135 for inclusion in the next tournament. Time is now of the essence.

Stephen Kimmel

Dear Editor:

I am somewhat confused about one of your statements regarding the castled position (1/0 Feb '80). If your attack was on a square the king moves through—then it is an illegal move and you'd better get Hyman 1400 a basic rule book of chess.

I have just received Sargon II, only played it once at level 2 and had no trouble in winning. I'm looking forward to trying level 4, which I hear is supposed to be about my level of play (1600). All this depends on getting A.T.C. off the screen. I have it down to 25 and holding. Try Sargon II in your next review; it may be the only time I can see it played—damn A.T.C. *

(Human 1600:AKA ATC25)

Stephen F. Smith
5127 San Vicente Dr.
Santa Barbara, CA 93111

* Air Traffic Controller

Frogspeak?

Dear Editor:

As a reader of your magazine for the past five months, I must applaud your efforts in enlightening the (so to speak) Little Frogs in the Pond. I have read the articles and advertisements from cover to cover; I have seen five months' worth of minis, personal computers, hand-helds, toys, as well as gadgets and add-ons that defy cataloging. I have read of so many versions of Basic that I must conclude that it's not very basic anymore.

However, judging from your magazine, Basic is the only language in the world. May I assure you, at this point, it's not. As the user of a somewhat larger corporate frog (NCR 8200 with IMOS-3, Cobol 74, 128K, drive disks, and various CRTs), I am suggesting that you are failing to fulfill the needs of a potentially large audience. I am referring to the untold thousands of corporate computer users; people who pay more rent, per month, for computers than many of the

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Line up a SoftCard demonstration at your Microsoft Consumer Products dealer today. They'll be glad to show you how the Z-80 SoftCard and your Apple computer combine to form a system that can't be beat for either practicality or pure pleasure by any personal computer available today. Or give us a call 206/454-1315, for more information.

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CIRCLE 166 ON READER SERVICE CARD

I/O, cont'd...

systems in your magazine cost. Believe it or not, we get bored, too. We like playing games, among other things. I'm sure that I speak for many, many other programmers when I say that, if you were to offer games in other languages, or a crash course in Basic, or conversions for Basic to other languages, or even games written in English (American will do), that your readership would have to increase.

Joseph R. Lawton
The Wulitzer Company
Holly Springs, MS 38835

Actually, we would like to publish programs in languages other than Basic, but we'd like to avoid Fortran and Cobol because they seem like a step in the wrong direction. Software written in Pascal or C would be most welcome and might satisfy your request for readability. (We also look forward to publishing software in Smalltalk and would consider Lisp.) Unfortunately we receive almost no software written in these languages and very little is distributed commercially. —Ed.

Timed-input Subroutine

Dear Editor:

One of the few commands left out of the TRS-80 Level II Basic is the timed-input function that most Basics have. This can come in very handy in game programs.

The solution is a very simple one, although I have never encountered it anywhere yet, so I'll pass the following little subroutine on to your readers:

```
10 INPUT "HOW MANY SECONDS TO YOU WANT  
TIMED INPUT?":S  
20 FOR I=1 TO (S*75)  
30 A$=INKEY$  
40 IF A$="" THEN NEXT I ELSE GOTO 60  
50 PRINT "OUT OF TIME": GOTO 70  
60 PRINT "YOU MADE IT IN TIME!"  
70 END
```

The FOR-NEXT loop determines how long the input lasts. Press any key to give an input. If no key is pressed before the time runs out, then a message will be printed telling that time has run out. This function could very easily be incorporated into many games that are out now, to add a little excitement and challenge.

Greg Perry
6104 E. 48th St.
Tulsa, OK 74135

More On Imagination Machine

Dear Editor:

Thank you for your kind and factual article in the May issue of *Creative Computing*. It is, by far, one of the most accurate articles done on the Imagination Machine to date.

I would like to make two comments. First, it is not necessary to poke a memory location to shut the sound off while loading the tape. I will agree, it gets "somewhat tiresome after the fourth or fifth time..." however, this is solved by simply turning the volume control to "zero." This should also be done while "CSAVING," since the data load is noisy.

Second, we have improved our documentation on the Imagination Machine. We realize that supporting the machine in the consumer's hands is our responsibility. It is basically a "beginners" machine in its simplest form and for those users, we will offer for sale our "Basic Tutor." The tutor package is a 20 lesson learning tool on cassettes with a 150 page manual that will actually teach "Basic." Rather than just reading a book, the cassettes will allow the user to learn, hands-on, at his own speed. This will be available by mid-June.

For those users that are past the beginner stage, we will supply, at their request, a technical reference manual. Machine language and an explanation of how our machine works are fully covered in the TRM. In addition, we have a toll free 800 number to help the store people and consumers

with any questions they may have. These phones are handled by both Sales and Technical people.

Howard R. Bollen
Executive Vice President
APF Electronics, Inc.
444 Madison Ave
New York, NY 10022

The toll-free number is 800-223-1264. —Ed.

Response From Micro Focus

Dear Editor:

Thank you for your authoritative article "Microsoft vs Micro Focus Cobol" (*Creative Computing* March 1980). It is obviously impracticable to discuss every aspect of powerful software, but we felt that your author, James McClure, achieved excellent balance in a very fair review.

His suggestions for the enhancement of CIS Cobol are closely in line with our ongoing development program. The decision to incorporate further language features is always a trade-off against available user space. However, for those who need these features, we plan a very full small-company Cobol implementation in the relatively near future.

As to the present product, the ANSI batch Debug module has by now been implemented in CIS Cobol, an enhancement which opened the way for the recent certification of the software by the General Services Administration. Another recent addition is an implementation of CIS Cobol for the DEC LSI-11 running under RT-11, while the software has for some time been available under ISIS-II, as ICIS-Cobol from Intel. A final small point is that CIS Cobol has always permitted the incorporation of assembler language subroutines.

Your readers may be interested to know that Micro Focus has had a U.S. office since late last year. The address of this office is:

Micro Focus Inc.
1601 Civic Center Drive
Santa Clara
CA 95050
(408) 984-6961

Peter Hewitt
Micro Focus, Inc.
U.K. Office: 68,
Acacia Road,
St. Johns Wood,
London NW8 6AG

Perspective on "Atari in Perspective"

Dear Editor:

I was dismayed to read the article "Atari in Perspective," in your April, 1980 issue by Len Lindsay. This piece, for which the choice of word *goofy* is perhaps too kind, hardly belongs with the generally fine quality found elsewhere in your magazine.

For years, the audio press has been laboring under advertising pressure requiring that they print "non-reviews" and useless "comparisons." One characteristic of such writing is the frequent restatement of the blatantly obvious. Mr. Lindsay's effort is perhaps even less informative than most.

In addition to the essential silliness of what he says, his writing style is itself childish. To choose one example: "The PET is one unit, designed as an all-in-one package theme." Since the terms *all-in-one*, *package*, *unit*, and *one* mean the same thing we have here a quite rare example of quadruple redundancy in a very short sentence. Too, things cannot be designed as *themes*. They can be designed with themes, but it is clear that the word *theme* is not appropriate here and that Mr. Lindsay has no idea what it means. As one reads through the article, other such solecisms abound, and it becomes evident that the writing is a rather accurate

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I/O, cont'd...

object moving at a high fraction of light speed will be foreshortened in the direction of its motion. In the case of a rotating disk, an observer at the center will see objects on the disk moving faster and faster as their distance from the center increases. The foreshortening will now be tangent to the circle of motion, and will increase as the radius increases. As a result, the surface area of the disk will be greater than π times the square of the radius. The length of each track will be increased by the reciprocal of the foreshortening, and the foreshortening will increase with the radius. Towards the edge, tracks could be light-years in length but still have their original radius. The only practical problem would be preventing centrifugal force from flinging the bits off the disk.

Kimball M. Rudeen
57 Taft Ave.
Lexington, MA 02173

Graphics Digital Clock Debugged

Dear Editor:

I was surprised to see in the April '80 Input/Output column that Mr. Sullivan found a "bug" in my "Graphics Digital Clock" program (October 1979, p. 110).

In checking out my copy again, I was unable to duplicate the error that Mr. Sullivan found, even after running it through several complete cycles in both 12-hr. and 24-hr. formats.

One possible explanation of this discrepancy is simple miskeying: When a 5 x 7 dot-matrix listing must be reduced in size for publication, it is easy to misread some critical characters, such as the "D1" in line number 370.

Also, the TRS-80 Level II Basic will sometimes give a false "NEXT without FOR" error signal. To see this, try the following little demonstration program:

```
10 FOR I=1 TO 20      60 NEXT I
20 IF I=10 GOTO 40     70 NEXT J
30 NEXT I             80 PRINT "OK"
40 FOR J=1 TO 20      90 END
50 FOR I=1 TO 20
```

I was not aware of this potential problem when I wrote the program. If I had been, I probably would have changed line 350 to read:

```
350 IF D1=C AND D2=D THEN D2=9
      (change underlined)
```

If I try to RUN this, I get: ?NERROR IN 70. The problem comes from reusing an index variable after exiting from a FOR loop before normal completion. If I change the index in lines 50 and 60 from "I" to "K," it will run all right. The Radio Shack Computer Services Center in Fort Worth suggests resetting the index to zero before reusing it (even though the FOR should reset the index).

This simple change should avoid any problem. As I said, the program runs all right on my TRS-80 as published. It seems that there are slight differences in the ROMs of some TRS-80s so some users may have to make the change shown above. I would appreciate hearing from anyone else who has had a similar problem.

Delmer D. Hinrichs
2116 S.E. 37th Ave.
Washougal, WA 98671

Order of Royalty

Dear Editor:

In reference to the article "DUKEDOM" (Creative Feb 80): Mr. Kaapke writes in his Historical Waiver that "A Duke would have as his lord not a king but a Count or an

Earl and would have under him Barons or Marquises." This is incorrect. The position of Duke is prominent in the five orders of nobility. In history one immediately thinks of William the Conqueror, Duke of Normandy, King of England; and the Duke of Burgundy who rivalled Louis VII at the time of Joan of Arc, for control of France. In more recent times we have Edward, Prince of Wales, who abdicated from the British throne and was Duke of Windsor. Prince Philip is currently Duke of Edinburgh.

The five ranks of peerage in order, are: Duke, Marquis, Earl (or Count), Viscount and Baron. This follows roughly upon the Continent as well.

Peter Fellows
108 Clearview Ave.
Ottawa, Ontario
Canada

Painful Language

Dear Editor:

In Strunk's* name, why do you bother to run articles on style and effective writing when you still insist on using the monstrous construct HE/SHE, HIM/HER, HIS/HERS?

This odious affectation needs to be thrown out with the lawyer's AND/OR, the engineer's THREE (3), and most everything written by the Federal Government.

The injury to the language is more painful than any alleged fair-play benefits. If you must, use HE throughout on even months; SHE on odd.

Michael D. Zorn
360 Carriage Dr., D
Santa Ana, CA 92707

*William Strunk, *Elements of Style*

Level I Double Width Characters

Dear Editor:

I have a simple method for producing wide characters on a TRS-80 Level I. Here is a sample program:

```
10 IN="HHEELLLOO!"
20 GOTO 10
```

(Note that a space must follow the quotation mark; there is no second quotation mark.) When run, the program first fills the screen with "HHEELLLOO!" Soon, the screen will freeze and change to "H E L L O !" in wide characters. One side effect is that this hangs the computer, so you must first press the RESET button before you can re-run the program.

Happy Hardware!

Ross Dexter Knights
5153 Echo Road
Bloomfield Hills, MI 48013

Gene Modifications

Dear Editor:

James Garson's program *Gene: A Genealogy Program* is well conceived and—when properly debugged—enjoyable to use.

As written, however, the program refuses to allow modifications to Name or Sex characteristics and it does not provide a complete list of descendants.

I believe the following changes will correct these problems:

- (1) Delete line 732
- (2) Correct line 720 to read 720 C1=0
- (3) Insert a new line 625 K=W

Eliakim Willner
1510 East 4th Street
Brooklyn, NY 11230

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Here is a review of two word processors. The opinions and unusual tastes expressed are those of the author.

Word processing for the Apple has been sadly lacking until recently. Now, with Super-Text and EasyWriter there is no longer a need for writers or would-be writers to work in frustration at a typewriter while several thousands of dollars worth of computing equipment sits idle, simply because there was no word-processing software available. Oh, there has been software, but, personally, I would hesitate to call it word-processing software. There were just too many limitations in the products.

Super-Text is put out by Muse Software, 330 N. Charles Street, Baltimore, MD 21201, and sells for \$99.95. It is a superb product written by Ed Zaron. EasyWriter is offered by Information Unlimited Software, 793 Vincente, Berkeley, CA 94707, and also sells for a few pennies under \$100.00. It was written in Fortran by a savvy gentleman by the name of John Draper. (Formerly known internationally for his exploits as a phone freak, Cap'n Crunch Draper has gone straight under the new identity of Cap'n Software.—Ed.)

Neither program is compatible with Apple DOS, but this is no problem. They run fast and are very efficient. Super-Text offers more utility than EasyWriter, but the latter, in my opinion, offers more future potential. If Cap'n Software incorporates the changes suggested by this writer and others, it will be in a class by itself. However, until they make

Voyle A. Glover, P.O. Box 212, Griffith, IN 46419.

Super-Text vs. EasyWriter

Voyle A. Glover

** Rating Table **

(scale: 1 to 10)		
	EZ	ST
a) versatility	7	10
b) utility	7	10
c) ease of use	10	8
d) documentation	8	6
a) disc system	10	9
f) speed	10	8
g) special features	7	9
h) printer routine	8	9
i) metering system	10	8
j) editing system	10	8
(sub totals)	87	83

(Negatives)

(scale: 0 to -5)		
1. auto-paragraph	-5	0
2. pagination	-5	-1
3. titling	0	-5
4. program recovery	0	-5
5. underlining	-5	0

Total Rating: 72 72

There are other minor things I could have rated negatively, but these items were included in the overall ratings and thus were not placed here. Only those items that were difficult to fit into the rating, yet were separately important, were included in the negatives. I did not, for instance, list file merging as negative because this was one of the items calculated into the rating. Thus, EasyWriter got a "7" both in "special features" and "utility," partly because they do not have this feature.

Super-Text got low marks in documentation for an unattractive and poorly-written manual.

those changes, I have to rate it about even with Super-Text. I like both of these programs for different reasons and if I did not have both, I would definitely get both.

Super-Text

Super-Text offers many special features, but perhaps the best thing it offers (for this writer, anyway) is superscripting, subscripting, underlining and boldface. (While EasyWriter does offer the sub- and superscripting [which was left out of the old manual], they do not offer underlining in a practical fashion. It takes lots of patience to underline

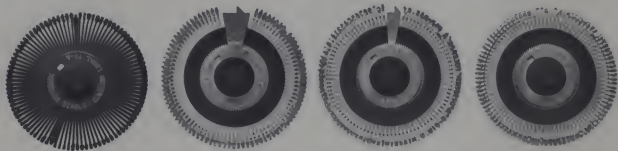
with EasyWriter.) Super-Text (version 2.0) also has upper- and lower-case capability and is designed to run with the Dan Paymar board [see below]. Super-Text also allows use of the Applesoft board (switch must be "up"). This new version also permits loading of all on-line files: you can load a file from either disk drive.

[Note: This is a plug-in unit which enhances the Apple's normal character generator with lower case and does not require an accessory slot. It is \$49.95 from Dan Paymar, Box C-109, C.S. 6800, Costa Mesa, CA 92627.—Ed.]

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CIRCLE 134 ON READER SERVICE CARD

Versus, cont'd...

Super-Text offers some unique features, such as a "multiple window" which allows a view of a horizontally divided screen. This allows you to make changes in a portion of your text while you have a copy of the same text below or above for reference. Thus, if you changed something and didn't like the change, you may opt to go back to the old version or jump to the other screen and make a new change there. Personally, I like the feature because I can always have the line I am typing right in the middle of the screen, instead of the bottom. It is a very useful feature.

I like both of these programs for different reasons and if I did not have both, I would definitely get both.

Super-Text has also incorporated a little something that is handy, provided you can force yourself to get into the habit of using it. You can, with one key stroke, cause the ":" character to become the word "the." Thus, each time you want "the," you simply hit ":". A nice feature, indeed. A several-key control sequence allows you to use colons, also.

I like the Autolink feature of Super-Text. Using Autolink, one can have access to all on-line files, and can even do a search and replace on every on-line file. If you wanted to replace a character's name in a novel, then using Autolink the program would call the next linked file, search it for the string or name, replace it with the string or name you indicated prior to the search and replace routine, save the updated file, load the next linked file, and so on. Definitely another plus for Super-Text.

Super-Text offers a math module within their program. This should prove to be a tremendous enticement for those businessmen who have reports, board meetings and other materials which require figures incorporated into the text. Using Super-Text, a secretary can type the report, type in the figures, and have all the math done (and check the boss' totals!) by the computer. The module features columnar additions with aligned decimals as well as direct

calculations. Thus, this program offers much for technical writers, accountants writing reports, secretaries given the task of making sure the boss is correct, and businesspersons doing a financial position analysis (for a bank loan, personal records, etc.).

Super-Text offers file merging, another nice feature. This can be of particular use when you want to insert tables, or perhaps contractual language or footnotes, into a text. There is also a very useful block copy, save or delete system that works with this. Using the block mode, one can separate a paragraph using special characters (Ctrl V), and then either save that section to disk, insert it into text elsewhere, delete the block only from your text, or delete the block markers.

EasyWriter

The important thing to remember about the EasyWriter program is that *it is easy*. There is just no comparison between EasyWriter and Super-Text when it comes to ease of operation. If ever a program deserved the name it has, this one does. In addition to being super-easy, this program is fast. I have never over-typed EasyWriter; that is, I have never been able to type so fast that I lost a character on a wraparound (where a word too large for the current line is automatically dropped to the next). This did happen with Super-Text, although there is a way to avoid this (by using the split screen and typing in the center at all times). EasyWriter saves fast, edits fast, loads fast; in every respect but one, it is a very fast, smooth program.

That one thing has to do with the commands for a partial printout of a file. If you want the first page of chapter three of your novel printed, insert ".e" at the beginning of your file, and you insert ".b" at the beginning of where you want your printout to begin. Then, another ".e" after that section of text will end printout. This all works well, but the problem is that the program processes everything. Thus, if you have a lot of text ahead of the part you want printed, you will sit idle for some time, waiting just as long as if you were getting an actual printout.

EasyWriter has a feature which makes it really shine for me, and it is one all klutzes (like me) will appreciate. With little fuss, you can make a master backup disk. This can even be done with only one disk drive, and the backup master will contain the complete EasyWriter program except for the logo. It is a comforting feeling

to know you can have all the backup copies you need. (Of course, the problem here is those friendly thieves who make a copy for a buddy. I hope that kind of person does not force EasyWriter to change this.) Data disks can be made at the same time, and again, "easy" must be emphasized. No parameters to put in, no "bloats" and "bruns" and "bsaves." Just a simple "y" or "n."

Proportional spacing is a very desirable feature of EasyWriter. Many printers now have this capability; if you've a printer which allows this feature, then EasyWriter is just the ticket. Using proportional spacing, there are no unseemly gaps in your printed text and all the text is neat and professional-looking.

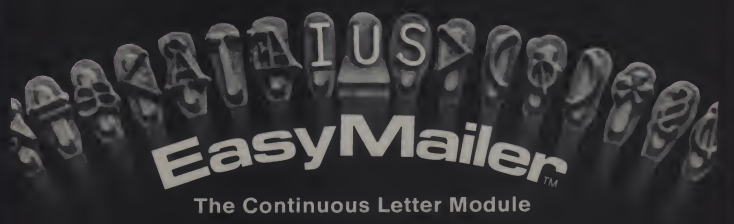
Provided you can force yourself to get into the habit of using it, you can, with one key stroke, cause the ":" character to become the word "the."

Unlike Super-Text, EasyWriter has an integrated edit/format system. This means that if you are typing merrily along and discover the need to make some revisions in an earlier part, there is no special mode or system you have to enter. You simply move the cursor to wherever you need it with a scroll or search command, and do what you need to do. Once more, the emphasis is *easy*. It is a simple job (and extremely fast) to move text around, edit, delete, and leap back to where you left off. One feature I especially like is the way that EasyWriter allows you to open up your text. A Ctrl G will insure that any "returns" you do will cause the text to split. This allows you to insert material very easily. (Super-Text also permits this kind of insertion, but it is not as easy or as versatile.) And when you are done, EasyWriter will automatically close up any gaps in your text, whether they are line gaps or spaces between words.

Going from the print system to the disk or the edit system is also very easy. If you have just printed your text out, then a simple "D" will put you into the disk system. There, you will be shown a list of commands, each explained but represented by one letter. Thus, a "G" would get a file and load it into memory, while an "S" would save whatever text was in memory under a name you specify. (However, as with Super-Text, when you ask for that file in the future,

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CIRCLE 220 ON READER SERVICE CARD

Versus, cont'd...

although the name is displayed, you can use the number—much easier.) Then you can, with a one-letter command, go back to the editor or to the print system.

EasyWriter has something else that is fantastic for klutzes. It has the ability to let you hit Reset and not lose a thing! I've had many occasions when I've goofed (you never do, right?), and gotten it all back together with a hit on the Reset button. (Not so with Super-Text. Perhaps someone who knows more

There is just no comparison between EasyWriter and Super-Text when it comes to ease of operation. If ever a program deserved the name it has, this one does.

about his Apple and about the monitor system would have had no problems, but I put in about six hours worth of typing using Super-Text when, in my best klutz technique, I tried to save the work to a data disk while the little door was open on my drive. I tried everything I knew, referenced the Super-Text manual, magazines, and Apple manuals, all in vain; I just could not recover.) So, if you're a bit of a problem shifting mental gears at times, EasyWriter could be what you need.

Finally, EasyWriter has a user-defined keystroke delimit capability that is exceptionally easy to use. The only fault with it is that you can only have one at a time. (This, according to Mr. Larry Wells, of EasyWriter, will be corrected "in the near future.") If you wanted, for instance, to have spaces every time you hit the slash, you may easily do it with the command "/v/160".

Problems And Complaints

I have several complaints about both systems, and must bring out some problems I have encountered. One, rather vexing to me as a writer, is the fact that EasyWriter has a titling feature which works just about the way I need it to work, but has a page-numbering system that is absolutely worthless. Super-Text comes along with a page-numbering system (even relative numbering for chapters) that is absolutely perfect, versatile, and all one would ever need, but has zilch for the page titling. Anyone who does any amount

of writing knows that on most manuscripts you are required to put some kind of title on each and every page, or at least the author's name. Both EasyWriter and Super-Text need to correct this problem.

Super-Text should rewrite their manual. It is not as clear as it should be, and definitely could use a condensation with amplification. In other words, they need to remove the repetitive material, insert more examples, and try to imagine some worst cases in user experience. I would also urge them to use a Qume or Diablo (or something similar) on which to write their manual. Dot matrix, in spite of its wide applications, is not really suited for textual material. It looks hokey and cheapens what is otherwise a quality item. It's like giving a loved one a nice

birthday gift in a paper bag. It'll get you by, but that's all.

I would also like to see Super-Text come out with proportional spacing. It would compliment their fine product and add immensely to its worth. Also, they might fix a small problem with their page numbering system. It seems that on short pages (as at the end of a chapter), you will not get a page number—consequently the next page number will be wrong. I do have to compliment Mr. Zaron, however, on the excellent justification routine he has incorporated into Super-Text; I have not had a gapping problem with it. However, if you turn EasyWriter's proportional spacing off and just evaluate the two on their ability to produce excellent justified copy, then Super-Text is definitely best. I

EASYWRITER

```
(asc asc)FORMATTING))

.p1 (causes printer to pause after each page)
.j8 (justification is turned on)
.d11 (proportional spacing is set)
.g54 (page length is set to 54 lines)
.a8 (single spacing is set)
.w18 (margin is set to 18)
.l64 (line length is set to 64 characters)
.v/160 (user defined (/) is - to a space now)
.c (centers the next line)

(asc asc)easywriter(asc))

////(asc)the above commands are variable and most may be placed
in the printer routine table that is displayed at each "print"
request. (asc)the ones that do have to be included as shown
are the user defined commands (.v/160 for instance), and the
"p1" which causes the printer to pause and allow you to insert
paper after each page.)
////(asc)asc causes the next alpha character to be capitalized
and is seen on the (asc)apple video in an inverse mode.
(asc)the slash bars (/) are user defined to give spaces.
(asc)these are recognized by the program as actual space
characters and will produce the exact number of spaces you
create. (asc)this is not true if you merely put spaces into
your text with the space bar. (asc)the shift (asc)m character
(1) causes a line feed and is only necessary in order to begin
a new paragraph.)
////(asc)asc)now, everything that is typed will be in caps,
until (asc) is pressed again. (asc)if you wanted to change
margin, line length, and proportional spacing, then you would
do the following:))

.w28 (setting margin to 28)
.d18 (changing proportional spacing to 18)
.l55 (setting line length to 55)

(asc)the following text is written using the above parameters.
(asc)these commands will be maintained until (asc)print"
commands are entered into the text that are different. (asc)
(asc)easywriter(asc) is a fast and efficient way to write,
taking little effort to use. (asc)all labeled commands shown
are saved "as is" when you save the file to disc. (asc)you
never have to reinsert them in that file again.]]
```

EASYWRITER

FORMATTING

The above commands are variable and most may be placed in the printer routine table that is displayed at each "print" request. The ones that do have to be included as shown are the user defined commands (.v/160 for instance), and the "p1" which causes the printer to pause and allow you to insert paper after each page.

Asc causes the next alpha character to be capitalized and is seen on the Apple video in an inverse mode. The slash bars (/) are user defined to give spaces. These are recognized by the program as actual space characters and will produce the exact number of spaces you create. This is not true if you merely put spaces into your text with the space bar. The shift M character (1) causes a line feed and is only necessary in order to begin a new paragraph.

Now, everything that is typed will be in caps, until (asc) is pressed again. EasyWriter is an effective and easy system to master. If you wanted to change margin, line length, or proportional spacing, then you would do the following:

The following text is written using the above parameters. These commands will be maintained until (asc)print" commands are entered into the text that are different. EASYWRITER is a fast and efficient way to write, taking little effort to use. All labeled commands shown are saved "as is" when you save the file to disc. You never have to reinsert them in that file again.

have run the same text and gotten a gap or two with EasyWriter where none appeared in Super-Text. (Both programs gap some without proportional spacing, but Super-Text does keep it to a minimum.)

EasyWriter needs to make easier the underlining, subscripting and superscripting, and while they're at it, combine these features with proportional spacing. They also need to get rid of the shoddy ".e" and ".b" routine or at least speed it up considerably.

EasyWriter has a titling feature which works just about the way I need it to work. Super-Text comes along with a page-numbering system (even relative numbering for chapters) that is absolutely perfect, versatile, and all one would ever need.

Although EasyWriter has automatic paragraphing, it really is not practical for most applications. Presently, when you give two line returns (Shift M's), you will get an automatic paragraph sequence on the printer. However, it then doubles the space between paragraphs; a double-spaced manuscript would have four lines between paragraphs! Thus, a single-spaced letter or text would have two lines between paragraphs. The easy way around this is to define the "slash bar" (/) as a space. Then when you reach the end of a paragraph, do a shift "M," a "Return," then hit four or five slash bars and begin your new paragraph.

Finally, I have some suggestions for updates that would really make both of these products even more attractive. First, I think they ought to include the ability to utilize bi-directional printing. Many of us have a printer with that capability. We need software that will allow it. The EasyWriter people have informed me that this feature will be incorporated into their "Easy-Mallor" printer routine, but not EasyWriter itself.

Another useful feature would be something along the order of the WordStar system's "end of the page" finder. That system draws a dotted line on the screen at a page break. Thus, one could know exactly where to insert footnotes without having a printout.

Something else that both need is a flexible titling and pagination system. There are as many different formats for manuscripts as there are different kinds of writing, and flexibility is a must.

Future Developments

Muse is coming out with an 80-column update of Super-Text utilizing the new 80-column, upper/lower case board. I have no dates, but I would presume that this update is now available or will be soon. Also, I am sure that Muse will remain competitive and innovative, bringing out updates and neat features. They seem to be that kind of company. (Anyone who can give an automatic "the" is "thinking" in my "direction.") Who knows, perhaps they will incorporate some of the suggestions in this review.

Easy Writer seems to have made the complete jump to a professional system—at least, that's what they've named it. It utilizes the 80-column board (you must have a monitor) and offers just about everything a word processor should. This new system, I'm told, will give you a "what you see is what you get" visual—on screen justification and suppression of control characters. Everything will look, on screen, exactly as it will on

paper. I understand the entire system, including the board, will go for something around \$500. It will give bi-directional printing, five user-defined characters at once, and file merging. Mr. Weiss informed me that they do, however, intend to update the present EasyWriter to almost all of the specifications of the new system except the 80 columns.

EasyWriter has something else that is fantastic for klutzes. It has the ability to let you hit Reset and not lose a thing!

Anyway, it seems that word processing has come to the Apple at last, and that we can take the worms out. As these manufacturers compete for our business, I have no doubt they will improve their product. We can only benefit. Meanwhile, I highly recommend both the EasyWriter and the Super-Text word processors.

As for the great question that is bothering all of you—"Which program did he use to write this review?"—I have to leave you with this: Only my editor knows for sure... □

SUPER-TEXT

FORMATTING

Super-Text uses "control" characters in the text for formatting. For instance, the "P" will tell the printer to indent the number of spaces you have put into the options, or "default" routine, and the "A" will tell the printer that the next character is to be capitalized. The "C" will cause all characters following to be uppercase until a Ctrl F.

If you need to change any parameters, then you must use a Ctrl F, followed by the desired settings. Thus, if you wanted to change your text at this point, then it would look like this:

F15,56,D

Now, everything will be double-spaced, with a

left margin at "15" and a right margin at "56."

Changing those values will automatically

re-adjust your text on printout. So:

F18,78,e

will now give you a different output, with a left margin of "18" a right margin of "78" and single spacing. Not difficult at all.

SUPER-TEXT

FORMATTING

PA Super-Text uses "control" characters in the text for formatting. After instance, the "P" will tell the printer to indent the number of spaces you have put into the options, or "default" routine, and the "A" will tell the printer that the next character is to be capitalized.

PA If you need to change any parameters, then you must use a Ctrl F, followed by the desired settings. Thus, if you wanted to change your text at this point, then it would look like this:

F15,56,D

PA Now, everything will be double-spaced, with a left margin at "15" and a right margin at "56." A Changing those values will automatically re-adjust your text on printout. Also:

F18,78,e

will now give you a different output, with a left margin of "18" a right margin of "78" and single spacing. A Not difficult at all.



Mountain Hardware ROMPLUS+

Steve North

Mountain Hardware's ROMPLUS+ board is an EPROM memory board for the Apple II with a capacity of 12K bytes. The board also has 255 bytes of on-board scratchpad RAM and two TTL inputs for user applications. The ROMPLUS+ also has an onboard control ROM that allows the other ROM software to be accessed easily via ordinary input and output commands.

All this is very nice, but not especially useful unless you're going to develop your own ROM-based software. However, Mountain Hardware also has an optional plug-in ROM for the ROMPLUS+ board, the Keyboard Filter, which takes advantage of this hardware to expand the I/O features of the Apple.

The Keyboard Filter generally interacts with the user and the other system software much more gracefully than other packages.

Like the other character generators we previously reviewed for the Apple, the Keyboard Filter draws software-defined character fonts on the high resolution graphics screen of the Apple to provide upper and lower case characters or anything else that can be drawn in a 7x9 dot matrix. The Keyboard Filter has some other interesting features which the other character generators do not, though, and it generally interacts with the user and the other system software much more gracefully than other packages. For example, the Keyboard Filter software can be activated by typing PR#5 (to get the attention of the control ROM) and then control-shift-M 1 (to turn on the Keyboard Filter installed in ROM socket 1). This is easier than loading a program stored on cassette or disk and also eliminates some fussing around to

avoid memory collisions with other programs.

The Keyboard Filter processes input and output by intercepting and processing characters like any other I/O device (such as a disk or printer). Most of its special functions are accessed by outputting control characters, either by PRINT statements or echoing them from the keyboard. The functions include selection of character fonts, colored and inverse video text, cursor movement, overstrike and "keyboard macros" (single-stroke shorthand entry of longer character sequences).

One of the TTL inputs on the ROMPLUS+ may be connected to the shift key on the Apple so that it can operate with some semblance to a normal typewriter keyboard. Since the Apple keyboard is normally uppercase only, the alternative is to define some particular control character to mean "toggle upper/lower case." It's much more people-oriented to type with the shift key. So, by looking at the status of the shift key the Keyboard Filter software can determine if the user is entering upper or lower case. Unfortunately, the Apple keyboard has the exponent and at-sign over the N and P keys respectively, so to type these symbols, if you've made the shift-key modification, you have to type a control character to toggle into "raw mode" to enter the symbol, and then type the control character again to get back into normal upper/lower case. Since these two symbols are not entered frequently, it's a very reasonable tradeoff to make.

The documentation for the hardware and software was better than average. It will provide the casual user with enough information to access the Keyboard Filter from Basic, and if you're interested in machine language programming or making your own ROMs, there's also enough documentation of low-level bit diddling. The ROMPLUS+/Keyboard Filter behaved nicely with Integer and Applesoft Basic in ROM and also talks with Applesoft in

RAM. However, it cannot be activated at the same time as other peripherals that overlap the address space at C800-CFFF (such as the D.C. Hayes Micromodem).

The quality of the hardware and software is what we've come to expect from Mountain Hardware. It's sophisticated, flexible, and easy to use. However, before buying one, consider that the software you write with embedded Keyboard Filter commands may not be very transportable to other Apples without this add-on. Also, it's a bit on the expensive side since you can get software character generators for about \$20 (although they are not as powerful or convenient, and don't have the shift-key modification). Still, for

The quality of the hardware and software is what we've come to expect from Mountain Hardware.

designing your own custom software or funny little programs in Basic, we recommend the ROMPLUS+/Keyboard Filter if you can justify the price.

The ROMPLUS+ with Keyboard Filter is available for \$200.00 from Mountain Hardware, Inc., 300 Harvey West Blvd., Santa Cruz, CA 95060. (408) 429-8600. □

Keyboard Filter Control Codes

- A No function
- B No function
- C Normal function — stops programs
- D Normal function — DOS commands
- E Turns on cursor movement mode
- F Font switching — followed by number of desired font
- G Normal function — bell
- H Normal function — backspace
- I Toggle inverse mode
- J No function
- K Select input from peripheral — followed by slot number
- L Toggle shift lock
- M Normal function — carriage return
- N No function
- O Toggle overstrike mode
- P Switch page being displayed
- Q Select output to peripheral — followed by slot number
- R Toggles raw mode
- S Prints keyboard macro — followed by key for desired macro
- T Selects color — followed by number of desired color
- U No function
- V Toggles shift key usage in modified Apples
- W Copy to end of line (for editing)
- X Normal function — delete line
- Y No function
- Z Clears current page

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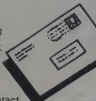
2
+ 2
= ?

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The Basic Programmer's Toolkit

Donald Goodman

Sandra Schwab

The PET computer can be compared with the Volkswagen Beetle of old — small, simple to operate, cheap enough for almost any budget, yet large enough to do many basic jobs well. However, the PET has a few primitive operations which make it less than a perfect instrument. It requires the operator to assign line numbers one at a time, by hand at that. If additional statements are needed within a program the re-numbering process is one which is ideal for creating torpor or ennui. Moreover, while the operator is punching out new numbers and counting "one-hundred-ten, one-hundred-twenty, one-hundred-thirty" like a Zen meditator counting out his exhalations, another part of his mind must remain alert for GOTO, GOSUB and similar detour signs which must be hand-altered along the way. If an entire section of a program needs to be deleted the operator must wipe it out one line at a time, another repetitive, half-a-brain process.

Discovering where an error has been made can be a frustrating, step-at-a-time search on a PET. It sits there saying "SYNTAX ERROR, with the implied "SEARCH ME," when the operator asks "Where is the error?"

These and similar PET hand-cranked procedures caught the attention of Harry Saal, a veteran in the field of personal computers. Mr. Saal, in his Nestar Systems, Inc., has manufactured a Basic Programmer's Toolkit for use on the PET. Actually, the device shouldn't be called a Toolkit. It's more like an automatic transmission.

Installing the Toolkit

PETs, like bears, come in three sizes: 8K, 16K, and 32K. While we had

several 8K PETs in use at Muskegon Community College, we requested one of the 32K Toolkits to fit into the new PETs we had on order. Our Toolkit was a single chip — a piece of black plastic about an inch and a quarter long and half an inch wide, as thick as two sticks of gum. Call it a miniature domino. The instruction manual accompanying the chip gives very clear directions and simple drawings telling what to do and what not to do. Our Toolkit prongs did

The search mechanism looks for balanced lines and logical statements. It will point out an unbalanced line but may, on occasion, suggest an erroneous solution.

not quite line up with the Computer ROM and had to be bent to fit. This is a minor problem but the prongs should not be bent much, or often. The installation process on the "new" PETs is about as complicated as changing a headlight on your car.

"Old" PETs can be equipped with a Toolkit which mounts on the memory expansion and the second cassette ports. The ability to expand the memory would then be nullified. There is also a Toolkit for older PET models which can be connected to Expandaman or Skyles memory expansion units.

Turning it On

To activate the Toolkit, the programmer keys in "SYS 49056" and presses the RETURN key. A response of (C) 1979 PAICS indicates that the Toolkit is functioning. The command must be given each time the computer

is turned on. Otherwise, the Toolkit will be ignored by the PET. However, the command can be keyed in anytime during a program, whenever the Toolkit's functions are called for.

Function: AUTO

(Key: AUTO)

Keying "AUTO" gives the program automatic line numbers. The Toolkit, unless directed otherwise, begins with line 100 and assigns lines in increments of 10. An operator may, of course, begin assigning lines at any number, and may use any increment. If a different interval is chosen, and if the program is interrupted (for instance, to correct an error) the Toolkit will remember the last number it presented, and will continue to present line numbers at the previously chosen interval, as long as AUTO is typed in again.

There were no problems with the AUTO function.

Function: RENUMBER

(Key: "RENUMBER" and first line number and interval desired.)

RENUMBERING gives the operator the ability to renumber a program in order to insert additional statements. For instance, suppose a program is being typed having the automatic 10 line intervals, 100 beginning line. The programmer discovers the need to insert 25 additional statements between lines 120 and 130. Without the Toolkit the operator has a long job ahead. The Toolkit, however, permits him to command: "RENUMBER 100, 25." The necessary space is thus created between 120 and 130. The command also, of course, gives 25 line intervals between all the other entered lines. The first line would still be 100; the second line would change from 110 to 125; the third line would change from 120 to 150.

Donald Goodman, Sandra Schwab, Muskegon Community College, Muskegon, MI 49442.

Toolkit, cont'd...

Renumbering will also change all previously entered GOTO, GOSUB, IF-THEN, ON-GOTO, and ON-GOSUB statements. This is a genuine time and brain-saver. GO-Hunting is one of the least productive and most frustrating of operator activities.

Caution with RENUMBERING

The RENUMBER command covers the entire program. If an operator has reserved, say, lines 300 to 400 for certain information, and, after typing line 900, decides to insert additional information between 850 and 860, a command to RENUMBER will give all lines a new number. The lines 300 to 400 may no longer be restricted to the information previously contained.

Function: DELETE

In an out-of-the-carton PET, if mistakes are discovered after typing, or if a program is under revision and entire lines need to be deleted, each incorrect line must be removed individually. The Toolkit allows the operator to delete as many consecutive lines as desired by using one command: DELETE 100-500, for instance. This action is similar to the PET's LIST command.

Caution with DELETE

If an operator wished to delete section 380-500 but typed only DELETE 380-, everything after 380 would be deleted. As with any massive command, this one has potential for a massive mistake in the hands of a day-dreaming operator.

Function: HELP

When the screen signals an error in a certain line, the command HELP will reprint that line, highlighting the error in reverse field. If the screen indicates a syntax error, then typing HELP will deliver the faulty line and, in many cases, will point out the error.

Caution with HELP

The search mechanism looks for balanced lines and logical statements. It will point out an unbalanced line but may, on occasion, suggest an erroneous solution. For instance, an extra entering parenthesis typed on a line will bring forth a suggestion that an additional final parenthesis ought to be added, rather than that the first one ought to be removed.

The error-marking cursor will usually stop at the last character which is acceptable to the computer. This

may be before the actual error.

The HELP function was found to be one of the most useful operations in the Toolkit when trying to debug a program. It might well be worth the price of the Toolkit all by itself.

Function: TRACE

TRACE is used for debugging. It is a rapid STEP procedure. Too rapid, in fact. The TRACE command sets into motion a trace that runs at the same time the program runs. The last six statement lines being TRACED appear in a small window in the upper-right-hand corner of the screen. The numbers appear very rapidly. They can be slowed by pressing the SHIFT key, but even the slowed speed is really too fast to allow an operator to follow on a printed program listing. Moreover, stopping the TRACE stops the program. The operator finds himself continually breaking into the running program while trying to catch the TRACE at the correct spot. A command of CONT will resume the TRACE after it has been interrupted.

When making a rapid search the operator may hold the shift key down and the line numbers will proceed rapidly down through the window. When he wants to stop at any point the operator lifts his finger off the key.

Caution with TRACE

Stopping the TRACE stops the program and presents, on the screen, a BREAK-IN statement which distorts the display of the program. In addition, the display of the TRACE in the window will be considered by the computer to be part of the values that have been put in. Whatever is shown in the window blocks out other parts of the screen display which would ordinarily appear there.

Function: STEP

STEP is a slowed version of TRACE. A window in the upper right hand corner displays six lines, but it changes only one line at a time as long as the shift key is struck and not held down. When making a rapid search the operator may hold the shift key down and the line numbers will proceed rapidly down through the window. When he wants to stop at any point the operator lifts his finger off the key. The

search stops and all movement in the window stops.

Caution with STEP

As with TRACE, the computer considers that the numbers appearing in the display are part of the program. This means that all inputting should be done below the window (the sixth line).

The STEP is in some ways easier to control than TRACE. It moves at a more leisurely pace, and turning it on and off requires only pressing or lifting one key. The TRACE procedure, remember, must be restarted with an additional statement each time it is interrupted.

Both STEP and TRACE can be turned off by typing the word OFF.

Function: DUMP

This command tells the PET to dump the extant values for all non-array variables onto the screen. It will give the programmer all the variables in the program followed by the value stored in its memory for each one.

I = 3

S = 2.4, etc.

The variables appear in the same order in which the computer executes the line numbers. GOTO statements, for instance, are followed in the dump operation as they would be in the program. Array statements will not be displayed during a dump operation.

During DUMP the display can be controlled by holding down the shift key. This option will be valuable in the event you have a large number of variables to be displayed. Pushing down the key interrupts the DUMP operation; releasing it allows the operation to continue.

Function: FIND

FIND is an index type of search. It activates what is known in the reading field as a scanning technique. Typing FIND, then typing whatever the operator is looking for, and then typing the inclusive line numbers, will result in a search for and a display of all lines containing the characters chosen.

If commanded, for instance, to find J, the computer would root out all J's, whether parts of words, comment statements, formulas, or what have you. However, it would pass over all J's set in quotation marks. If the operator calls for a search for "J" (note quotes) the computer will search for only those J's enclosed in quotation marks. (i.e., PRINT "JOE", or INPUT statements, or IF A \$ = "JOE" THEN 20, or similar statements.)

However, the search will not recognize individual letters in key words which have been stored as

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Toolkit, cont'd...

single bytes. For instance, a FIND N command will not turn up PRINT, INPUT, END, OR THEN. Indeed, a FIND PRI command will not turn up any PRINT statements.

Function: APPEND

APPEND is used to attach a second program to the end of a previously finished program. Simply appending a program does not change the numbering of the original program. However, a command to RENUMBER will change the line numbers of both programs. The computer will consider the marriage to be complete, that the two are now one.

Caution with APPEND

If the original program and the appended program contain overlapping line numbers (i.e., each has a line 270) and the appended program contains a GOTO 270 statement, and the RENUMBER command is given, the renumbered program will now refer to the line in the first program which corresponds to the original 270.

The operator must be sure that the appended program has larger line numbers than the original program when it is written. If this is not the case, the operator would have to renumber the program to be appended and re-save it onto tape or disk in its renumbered form. It could then be appended without confusion.

Summary

The Basic Programmer's Toolkit manufactured by Nestar Systems, Inc., is a simple-to-install, easy-to-master addition to the PET computer. It is a device with nine specific jobs, and it does them all very well. As long as the directions in the manual are followed, the purchaser should have no problems installing it. As long as its function and its minor foibles are understood the operator should have no problem using it.

It won't turn a PET into a wall-sized IBM, but it sure makes the little critter run smoother. And it will save on repair bills fixing up bored and babbling operators, since the Toolkit performs easily and automatically much of the drudgery formerly done by hand. That's what computers are for, isn't it?

The Basic Programmer's Toolkit is available from Nestar Systems, Inc., 430 Sherman Ave., Palo Alto, CA 94306, (415) 327-0125, for old model PET, \$79.95 (Model TK-80P) and for the new PET, \$49.95 (ROM only, Model TK-160).

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Basics Comparison Chart

● means the feature is in this BASIC.

BASICALLY BASIC VARIABLES

Long Names
Short Names

TYPES-NUMERIC

Integer
Floating Point
Double precision

TYPES-STRING

DEC Style
HP Style

TYPE DECLARATIONS

DEFINT
DEFSNG
DEFDBL
DEFSTR

ARRAYS

DIM
Numeric
String

INITIALIZATION

Set to 0 or null
Memory trash
Unknown

ARITHMETIC

COMPUTATION

Binary Float point
16 bit Integer
BCD Float point

ASSIGNMENT

LET
MIDS on left

OPERATORS

Arithmetic (+/*-etc)
Relational (gt, lt, etc)
Logical (AND, OR, NOT)
Boolean
16 bits
String relational
Concatenation

FUNCTIONS

ARITHMETIC

ABS
EXP
FIX
INT
LOG
LN
MOD
RAD
RANDOM
SGN
SQR

TRIGONOMETRIC

DEC
RAD
ATN
COS
SIN
TAN

ATARI
APPLE INTEGER
APPLESOFT
EXIDY
TMS 80 LEVEL I
TMS 80 LEVEL II
TMS 80 DOS
PET

Long Names	●	●	●	●	●	●	●
Short Names	●	●	●	●	●	●	●
Integer	●	●	●	●	●	●	●
Floating Point	●	●	●	●	●	●	●
Double precision	●	●	●	●	●	●	●
DEC Style	●	●	●	●	●	●	●
HP Style	●	●	●	●	●	●	●
DEFINT	●	●	●	●	●	●	●
DEFSNG	●	●	●	●	●	●	●
DEFDBL	●	●	●	●	●	●	●
DEFSTR	●	●	●	●	●	●	●
DIM	●	●	●	●	●	●	●
Numeric	●	●	●	●	●	●	●
String	●	●	●	●	●	●	●
Set to 0 or null	●	●	●	●	●	●	●
Memory trash	●	●	●	●	●	●	●
Unknown	●	●	●	●	●	●	●
Binary Float point	●	●	●	●	●	●	●
16 bit Integer	●	●	●	●	●	●	●
BCD Float point	●	●	●	●	●	●	●
LET	●	●	●	●	●	●	●
MIDS on left	●	●	●	●	●	●	●
Arithmetic (+/*-etc)	●	●	●	●	●	●	●
Relational (gt, lt, etc)	●	●	●	●	●	●	●
Logical (AND, OR, NOT)	●	●	●	●	●	●	●
Boolean	●	●	●	●	●	●	●
16 bits	●	●	●	●	●	●	●
String relational	●	●	●	●	●	●	●
Concatenation	●	●	●	●	●	●	●
ABS	●	●	●	●	●	●	●
EXP	●	●	●	●	●	●	●
FIX	●	●	●	●	●	●	●
INT	●	●	●	●	●	●	●
LOG	●	●	●	●	●	●	●
LN	●	●	●	●	●	●	●
MOD	●	●	●	●	●	●	●
RAD	●	●	●	●	●	●	●
RANDOM	●	●	●	●	●	●	●
SGN	●	●	●	●	●	●	●
SQR	●	●	●	●	●	●	●
DEC	●	●	●	●	●	●	●
RAD	●	●	●	●	●	●	●
ATN	●	●	●	●	●	●	●
COS	●	●	●	●	●	●	●
SIN	●	●	●	●	●	●	●
TAN	●	●	●	●	●	●	●

STRING

ASC
CHR\$
INSTR
LEFT\$
LEN
MID\$
RIGHT\$
STRING\$
STR\$
VAL

OTHERS

DEF FN
FRE
MEM
TI
TIS
TIMES

CONTROL OF PGH FLOW BRANCHES

GOTO
IF-THEN
ELSE
ON-GOTO

SUBROUTINES

GOSUB
RETURN
POP
ON-GOSUB

LOOPS

FOR
NEXT
STEP

OTHER

END
STOP
REM

INPUT / OUTPUT

INTERNAL
DATA
READ
RESTORE

KEYBOARD

GET
INKEY\$
INPUT
LINE INPUT

TO SCREEN

PRINT
PRINT AT, @
PRINT USING
SPEED

TABULATION

NULL
HTAB
VTAB
POS
SPC
TAB

MODES, MOTION

Cursor Movements
CLS
HOME
FLASH
INVERSE
NORMAL
TEXT

ATARI
APPLE INTEGER
APPLESOFT
EXIDY
TMS 80 LEVEL I
TMS 80 LEVEL II
TMS 80 DOS
PET

ASC	●	●	●	●	●	●	●
CHR\$	●	●	●	●	●	●	●
INSTR	●	●	●	●	●	●	●
LEFT\$	●	●	●	●	●	●	●
LEN	●	●	●	●	●	●	●
MID\$	●	●	●	●	●	●	●
RIGHT\$	●	●	●	●	●	●	●
STRING\$	●	●	●	●	●	●	●
STR\$	●	●	●	●	●	●	●
VAL	●	●	●	●	●	●	●
DEF FN	●	●	●	●	●	●	●
FRE	●	●	●	●	●	●	●
MEM	●	●	●	●	●	●	●
TI	●	●	●	●	●	●	●
TIS	●	●	●	●	●	●	●
TIMES	●	●	●	●	●	●	●
GOTO	●	●	●	●	●	●	●
IF-THEN	●	●	●	●	●	●	●
ELSE	●	●	●	●	●	●	●
ON-GOTO	●	●	●	●	●	●	●
GOSUB	●	●	●	●	●	●	●
RETURN	●	●	●	●	●	●	●
POP	●	●	●	●	●	●	●
ON-GOSUB	●	●	●	●	●	●	●
FOR	●	●	●	●	●	●	●
NEXT	●	●	●	●	●	●	●
STEP	●	●	●	●	●	●	●
END	●	●	●	●	●	●	●
STOP	●	●	●	●	●	●	●
REM	●	●	●	●	●	●	●
INTERNAL	●	●	●	●	●	●	●
DATA	●	●	●	●	●	●	●
READ	●	●	●	●	●	●	●
RESTORE	●	●	●	●	●	●	●
GET	●	●	●	●	●	●	●
INKEY\$	●	●	●	●	●	●	●
INPUT	●	●	●	●	●	●	●
LINE INPUT	●	●	●	●	●	●	●
PRINT	●	●	●	●	●	●	●
PRINT AT, @	●	●	●	●	●	●	●
PRINT USING	●	●	●	●	●	●	●
SPEED	●	●	●	●	●	●	●
NULL	●	●	●	●	●	●	●
HTAB	●	●	●	●	●	●	●
VTAB	●	●	●	●	●	●	●
POS	●	●	●	●	●	●	●
SPC	●	●	●	●	●	●	●
TAB	●	●	●	●	●	●	●
Cursor Movements	●	●	●	●	●	●	●
CLS	●	●	●	●	●	●	●
HOME	●	●	●	●	●	●	●
FLASH	●	●	●	●	●	●	●
INVERSE	●	●	●	●	●	●	●
NORMAL	●	●	●	●	●	●	●
TEXT	●	●	●	●	●	●	●

Going Computer Shopping ?

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The small business owner who knows what to look for in computers can have a long, profitable experience with a system virtually tailor-made to his or her needs. A wrong choice could leave that same entrepreneur with an expensive orphan. But to be a good shopper, you must be knowledgeable enough to ask the right questions.

In the crowded marketplace of small computers one hears all sorts of claims and counterclaims; all kinds of promises and pledges. Over the next

Deciding which computer is right for your operations, or whether a computer is the right way to go at all, is largely a matter of good planning.

five years, that marketplace will likely get more crowded. At latest count there were more than 150 different suppliers of small business systems, but in fact hardware from system to system is very similar. As far as computer programs go (the software, or the instructions that tell a computer what to do and when) one general ledger program is much like any number of others. So, how do you differentiate? What is the best system for you?

Deciding which computer is right for your operations, or whether a computer is the right way to go at all, is largely a matter of good planning. Specifically, planning based on the realities of your particular business. Say you have made the decision to computerize. You have assessed your business situation and determined that the required investment is cost-effective for a service that will automate what previously cost more in clerical labor.

Your total investment will include everything — hardware, software, and installation. It is important at this point that you begin thinking of the computer as a solution — a way to solve

your paper-handling problems. With that in mind, you can see why it is absolutely necessary to understand your problem — the business problem you want the computer to solve. Too many entrepreneurs do not. Along these lines, a frequent mistake — once the decision is made to computerize — is going for total automation. This is an invitation to trouble, because it takes a certain amount of time to accustom yourself, your employees, and your business to computerization. A better approach would be a slower, phasing-in of a business-wide computer system. This, again, is a function of how well you understand the problem you want the computer to solve.

Think About Tomorrow's Needs

Clearly define what you would want from a computer system. Include what you want today, and what you believe you will need a few years from now. As a general rule of thumb, figure on having the system work for you at least three years. At this point, however, we might offer some words of caution: Some manufacturers make a sincere attempt to quantify computer systems by size of business. In other words, you will hear a certain level of computer power described as "typical" for a business doing "under \$1 million" in sales. In fact, it is virtually impossible to categorize computer need by size of business.

After you have defined the problem and have a rough idea of how much you would be willing to spend to solve it, a picture will begin to emerge of what you will need in the way of a solution. Owning and running your own business, it is unlikely that you will have the time to assess every make of computer in terms of your particular needs. The independent computer dealer does it for a living. Frankly, we cannot over-emphasize the importance of seeking out and talking to a reputable dealer. Not only is he an expert on small computers, but he is a small businessman himself. He can empathize with the problems of small

business management and make it absolutely clear how a computer can help you run your business the way you want to run it. He supplies the best computer equipment he can find, and combines it with the application programs necessary for specific needs such as your own. (Application programs are the written instructions you apply to tell the computer what you want it to do, such as a certain accounting function.)

Choose Carefully

We recommend that you select a dealer with the careful deliberation on which you would choose an attorney, banker, or financial manager. The thing to look for is a dealer's record of success in solving business problems

We recommend that you select a dealer with the careful deliberation on which you would choose an attorney, banker, or financial manager.

similar to yours. Remember, too, that if he is unwilling or unable to listen carefully to your particular business problem, and provide you with a "hands-on" demonstration of a system *specific* to your business needs, beware. Take your business to someone who understands your problems.

There are plenty of horror stories about computer buyers who are undersold as well as oversold. One individual we know of who purchased a relatively inexpensive, so-called personal computer recently, soon discovered that it simply would not do the kinds of jobs his business would eventually require. He was left with several thousand dollars worth of essentially useless computer hardware. On the other hand, we know of too many instances in which unwary buyers purchased more computer power than they would ever need. The

moral here, again, is to know precisely where your business is today and where it is heading tomorrow — and the next few years. A computer system capable of supporting 20 terminals is not for you if, after consultation with a dealer, you have established a need for six. Another thing to keep in mind is the importance of *modular growth*. By this, we mean your computer system should be expandable — able to grow with your business in increments. For example, a computer system that runs your accounts receivable — giving you up-to-minute information and reports on who owes you what, when, and for how long — might be the perfect solution for your problem now. But, as your organization grows, you will likely want and need a more extensive system that offers inventory control and customer mailing lists. You might well need another terminal or two. Be sure the system in which you invest can easily grow with you at minimal cost. Avoid the situation where you will be forced to convert to an entirely new and different system. Here, again, consult your dealer and clearly spell out the requirements of your business.

The small business system is a tool that provides quick, inexpensive access to information important to your business. Naturally, how you apply that information is purely a

function of your own business ability. If you are a good business manager to begin with, your small business computer will very likely enhance that. It will help you make better forecasts, help you be more confident in your business decisions, reduce operating costs, and help you provide better customer service.

Cutting your operating costs — lowering the costs of doing business — takes on even more importance in an

Be sure the system in which you invest can easily grow with you at minimal cost.

era of economic uncertainty, particularly in inflationary times. A few years ago it was important for a small business to track costs and plan profits. Today, it is a matter of survival. The point is that the tools are now available to help you deal successfully with a changing — and not always pleasant — economic environment. To dismiss the computer as something you can do without simply because you always have done without one runs contrary to a very basic law of nature, as well as business — that whoever cannot adapt to a changing environment is doomed to extinction.

Successful entrepreneurs have long been aware that business success blends science and art. While the art is up to you, the small business computer has advanced the science to a new height and put it within reach. What the small business computer cannot do — and will likely never be able to do — is turn a poor manager into a good one. Your ultimate business decisions rest with you.

Talking in general terms about small business computers, especially what they can do for the individual business, poses hazards, simply because of the vastness and diversity of small business itself. Hence, the usefulness of talking to an independent dealer. It should be noted, however, that small business computers are making their presence felt in a dramatically increasing number of installations worldwide. They are finding homes in as wide a variety of small businesses as the number would seem to indicate. At the end of 1978, according to industry surveys, more than 70,000 small business systems had been installed. By 1980, the figure is expected to jump to more than 135,000, and by the end of 1982, more than a quarter of a million computers will be at work.

You owe it to yourself to determine if the small business computer is good business for you. □

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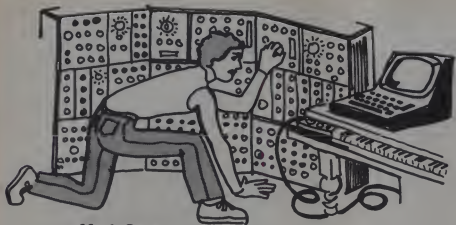
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CIRCLE 124 ON READER SERVICE CARD



Mark Garetz

Reminiscences of the Good Old Days—over five years ago! Incidentally, since this publication now forbids the word "microcomputer," the title presents paradoxes of its own—but it's a nice term.

My wife has a new word she uses to describe me, relative to my love for little computers—micropath, which, if you haven't already figured it out, is a derivation of psychopath. And, I guess, looking back on the almost 5 or so years that I have been involved with microprocessors and their related sundry hardware, she's right.

At times I will disappear into the computer room and emerge hours later bleary-eyed and cursing about a piece of hardware or a software routine that won't work the way it should, or at least the way I thought it should. She usually offers me encouragement, though, gives me something cold to drink and off I go back to slug it out with the stubborn computer for a few more hours.

Let me start at the beginning, how I got into all this and why. I play the synthesizer (an electronic music device) but I really don't have the talent or the patience to become a keyboard virtuoso. This was frustrating, but at least in electronic music you can get away without playing the keyboard of the synthesizer very well, as long as you have a multi-track tape machine and an ear for what sounds good. In fact, some synthesizers don't even have keyboards.

When synthesizers first appeared commercially, about 1964, I longed to have one but my extremely limited budget wouldn't allow that. So I decided to build one. I had dabbled in electronics a bit before (I'd built a

few unsuccessful kits and a thing or two out of Popular Electronics) so I felt reasonably confident that I could produce a synthesizer as good as the commercial units. (Boy, was I naive!) This is how I really started to get involved in electronics.

Well, I struggled with the synthesizer for a few years and then my financial situation improved to the point where I could afford a real synthesizer and a multi-track tape machine. I still needed more "modules" for my system so I decided to build them. My electronics knowledge had grown over the years so those came out OK. I started fixing

There was this guy named Bob Marsh who had started a small company known as Processor Technology, and Roger Mellen who had a little company with the strange name of Cromemco and a silver-haired sage by the name of Gordon French who had a computer that worked!

synthesizers for other people in my spare time.

This was about the time that the pong game appeared in pizza parlors, bars and other such places. A friend of a friend knew someone who knew someone who could get us the PC board for a four-player Pong-Hockey game made by one of Atari's competitors for about \$50 with most of the IC's set into place but not soldered. The board had about 95 TTL IC's on it. We said, "Sure." I don't know if my friend ever got his working, but I wasn't going to let \$50 go down the drain.

Confessions of a Micropath

Is there any hope?

Eventually I got it to work and I was one of the first people to have my own Pong game. About a year later Atari introduced their first home model. Meanwhile I ran into a person named Ned Lagin who was hooked up with the Grateful Dead (for those of you who never emerge from your respective computer rooms, the Grateful Dead is a rock group) and he played the synthesizer and was using an Interdata mini-computer to control it. He was working on an album (Seastones—Lagin and Lesh) and was using the computer extensively in its production. He also used the computer in live performances as a quasi-intelligent performer that responded to events happening on stage. This was all very exciting!

About a month after I met Ned, that first fateful article appeared in Popular Electronics describing the Altair. The Altair certainly was cheaper than Ned's Interdata and conceivably within my budget. Could I use the Altair to do the same kind of things with my synthesizer as Ned was doing with his?

I immediately rushed over to Ned's to show him the article. He informed me that he had already placed his order. I decided to hold off and do some more research since I knew absolutely nothing about computers.

At that point in time hardly anybody knew anything about chip computers and there certainly weren't any books on the subject—Intel Product Literature was about it. I discovered the Mark-8 computer articles—an 8008-based system. Godbout Electronics was selling 8008 chips for about \$50, so I thought I would look deeper into building an 8008 system from scratch.

Well, the 8008 is a real strange little chip, and it's even stranger when you don't understand anything. This put me off the 800 series from Intel. About the same time Motorola had announced the 6800. I rushed down to the local distributor and paid

\$35 for the giant Motorola manuals and also gathered up all the free literature I could. The Motorola manuals were confusing and not very clearly written. They make perfect sense now, but now I'm not a novice.

Even though the Motorola manuals were confusing, they were great compared to what Intel had released, which was downright cryptic! Little glimmers of understanding were flashing in my brain.

Enter the Godsend—The Homebrew Computer Club! At that time Homebrew, as we call it, was about

I would like to point out that no one has really credited Chuck Peddle for bringing the microprocessors within reach of all of us.

fifty guys crammed into a little classroom (The Orange Room) on the grounds of the Stanford Linear Accelerator, who were all about in the same boat as I was. We were all learning and gaining insights from each other. There was this guy named Bob Marsh who had started a small company known as Processor Technology, and Roger Mellen who had a little company with the strange name of Cromemco and a silver-haired sage by the name of Gordon French who had a computer that worked! Steve Dompier was playing "Fool on the Hill" from his Altair, broadcasting the switching noise over an AM radio. These were exciting times. We were all pioneers (now I know how to tell the pioneers—they're the ones with the arrows in their chests). Homebrew has now grown to over a thousand members.

By now it was August and these strange ads had appeared from a company called MOS Technology. They were announcing a new line of microprocessors for \$20 and up, \$20.00! And, they said you could buy the things at the upcoming Wescon show in September. This was unheard of. Remember that at this time an 8080 was still \$175.00.

What a furor this created. Intel and Motorola seemed to be implying that the \$20 price was a phony come-on, like you could only get that price if you ordered a million units. Other people were convinced that it was an out-and-out fraud. One salesman I talked to was convinced of this, and I remember him distinctly telling me that the microprocessor chips had

reached their bottom price—\$175—and that we'd never see them go any lower. I countered by saying that soon we'd see the price of microprocessors drop to under \$10 in the next year or so. He said "Never!"—told me I was crazy and everyone else standing around agreed with the salesman.

The only thing to do was to wait and see what happened at Wescon. Well, along came the day of the show and, sure enough, there was MOS Technology but no chips in sight. I was informed that no selling was allowed on the floor, but that the chips were available in their hospitality suite. Away I went to the hospitality suite to find out the real story.

There they were! A big glass bowl of chips and stacks of manuals. They also had a KIM and a TIM system running. A guy named Chuck Peddle was there, happy to explain the features of his newly born baby. They piled me with a drink and I sat down on one of the couches with a copy of the manual to have a look. The damn thing made sense. Take my money!

I went home that evening with a 6502 chip and a hardware and

I still needed more "modules" for my system so I decided to build them.

software manual. My own computer and all for \$25 dollars. Little did I know that I would invest another \$300 before my homebrew 6502 system would work.

It is interesting to note that this very day Intel and Motorola announced price reductions on their processors to \$79.00. The microcomputing craze was really beginning. I would like to point out that no one has really credited Chuck Peddle for bringing the microprocessors within reach of all of us.

Everyone with an Altair or Im sai seemed to have Microsoft Basic running or Li Chen Wang's Palo Alto Tiny Basic and all kinds of games were proliferating at Homebrew. However, I was now stuck with a 6502 system and there was no 6502 Basic out, or any other applications program for that matter. A guy who worked for HP had designed a 6502 system with an Integral video display, cassette interface and 8K of memory on board (8K was a lot in those days) and he was writing a 6502 integer Basic for it. He showed it to all at Homebrew, but since he had designed it at HP, he wasn't sure he could release any of it to us with 6502's.

That guy was Steve Wozniak who, when he finally did get permission to release the stuff, teamed up with Steve Jobs, another Homebrew member, to form the Apple Computer Co.

An insatiable appetite for whatever is new, be it hardware or software, is the sign of a true micropath. As an example, my collection of hardware grew to the point where I had:

6502 Homebrew System
Im sai w/ Cromemco ZPU
TRS-80 Level II Disk System
Commodore PET
RCA COSMAC VIP
Zilog MCB (Single Board Computer)
General Automation SPC-16 w/12K Processor Technology SOL
ASR-33 TTY
Electric Printer
North Star Disks,
speech synthesizers, video displays, cassette interfaces and more.

And I just got an 8086 chip set and will probably get a Z-8000 before too long. Now you can see where my wife got the word micropath.

Somewhere along the line I had to start my own microprocessor company—HUH Electronics—just to support my habit.

But I'm slowing down. Some of the equipment in the above list has been sold. HUH Electronics has merged into California Computer Systems and now I'm an independent consultant.

By now you may be wondering why I called this article "Confessions of a Micropath." I have one big confession to make and that is, that in all the years I've been involved with

Somewhere along the line I had to start my own microprocessor company—HUH Electronics—just to support my habit.

microprocessors, I really haven't done anything useful with them. The closest I've gotten is that I'm using the Electric Pencil right now to type this article. I never got the computers hooked up to my synthesizers; in fact, the computers take up so much room that I've had to put the synthesizers in the closet.

So if you're a micropath, or are heading in that direction, don't worry about trying to justify your hobby to them what don't know. Those of us that are considered experts in this field don't do a hell of a lot with our computers either. We don't have the time. We're busy finding out what's new! □



Stocks and Listed Options

Part 3-Call Option Writing and Program OPTION

Alfred Adler Ph.D

Review

In Part 1 of this series we introduced the reader to stocks and the stock market. We pointed out that a share of common stock is not a debt instrument, as is a bond, but rather represents part ownership in a venture. The stock market was presented as a place where buyer and seller, or their representatives, meet and engage in an auction. Brokers were discussed as the usual form of representative, and the reader was introduced to the harsh realities of life in the form of the ubiquitous commission. The differences in possible investment attitudes were touched on briefly, and the discussion then moved to puts and calls and the listed option markets. One or two of the more obvious option strategies were mentioned and a Table was presented comparing the profits and losses that could be

realized by various modifications to these strategies.

In Part 2 the discussion of option strategies was continued with a brief presentation of the six basic strategies. The discussion then moved on to combination strategies, with cov-

Program OPTION permits the examination of a large number of possible ma- neuvers in a short time.

ered and uncovered calls, and covered and uncovered straddles receiving fairly detailed treatment.

By now the reader should be fairly familiar with the terminology, the rights and responsibilities of option writers and buyers, and the profit versus stock price graphs for the six basic maneuvers. From this point on it will be assumed that the reader has

read the previous articles in the series, and can refer to them as necessary.

Call Writing

In Part 1 of this series it was stated that covered call writing is "more conservative and more consistently profitable than the simple buying and selling of stocks." It was also mentioned that "very conservative financial institutions...have begun trading options." The vast majority of their option trading is covered call writing. Thus this particular strategy is without a doubt the most popular single stock/option strategy engaged in today. It is certainly fitting that we examine it in some detail and prepare whatever programs are necessary to assist.

In Part 2 of this series call writing was discussed in terms of profit versus stock price on expiration day. However, before one sells calls against a long stock position it might

be desirable to have additional information on the other possible outcomes as well as a more complete statement of the implied input data.

Before getting involved in the details, it is necessary to distinguish between an opening option transaction and a closing option transaction. They are quite different and will be treated separately. An opening option transaction occurs when an option not previously owned is sold or when an option not previously sold, is bought. A closing option transaction occurs when a previously bought option is sold, or when a previously sold option is bought back. All option transactions are either opening transactions or closing transactions. There is no other kind. The option involved in a closing transaction must be the same, meaning the same underlying stock, the same expiration date, and the same exercise price, as the option involved in the corresponding opening transaction. A closing transaction, in short, is a termination of a position acquired through an opening transaction.

Opening Transactions

Calls may be sold against an existing long stock position or against a position taken simultaneously with the sale of the calls. If the former, then the seller creates an immediate cash credit in the amount of the net proceeds of the option sale. If the latter, then the cost of the stock purchased is diminished by the net proceeds of the option sale. By

"net" is meant the total premium income minus the commissions on the option sale. It would be interesting to have a statement of the cost of the stock purchased, if any, as well as the cost of the total amount of stock committed to the strategy. In addition, it would be informative to have a further breakdown into the net sale proceeds of the options: the net purchase, that is, the cost of stock

All option transactions are either opening transactions or closing transactions.

purchased minus the net option proceeds, and the net sum committed, that is, the total cost of stock committed minus net option proceeds. It would be further desirable to have a statement of the time to expiration, the lower breakeven point both in dollars and in percent, and the same for the upper breakeven point, if any.

Most important, a statement of the income, if the options are permitted to expire, in dollars, percent, and annualized percent; and a statement of the profit, broken down into income and capital gain on the stock, if called, in dollars, percent, and annualized percent. "Income," as used above, is the sum of the net option proceeds and dividends, less margin interest. "Profit" is the sum of "Income" and

stock capital gains.

Closing Transactions

Before closing an existing option position it is certainly desirable to examine the consequences in some detail. In this case there are a number of alternative ways in which a closing transaction might be made. If options have been sold at a hedge ratio greater than 1, it might be desirable to sell only the uncovered options while retaining those that are covered. This would probably be the case if the stock were inching up past the exercise price of the call. On the other hand if the option price has dropped precipitously, it might be wise to buy them back, hoping that the price will rise again and they can be resold. It is amazing how often this can be profitably done. This type of maneuver is a prime example of the importance of including broker's commissions in the calculations. Unless the price spread between the buyback and subsequent resale of the option is greater than the round trip commissions, there will be no profit except, of course, to the broker. Finally, if the underlying stock has become less attractive, it may be desirable to close out the entire position.

If a closing option transaction is made, the value of the net option proceeds changes. Whereas before it equaled the proceeds of the sale of the options less commission, now there is the additional deduction of the cost of repurchase and the repurchase commission. A statement of the new net option proceeds

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
JAN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
FEB	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31											
MAR	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
APR	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	
MAY	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151
JUNE	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
JULY	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212
AUG	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243
SEPT	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
OCT	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304
NOV	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	
DEC	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365

in leap years, after Feb 28, add 1 to the tabulated number.

Figure 1

Investment, cont'd...

as well as the time since the opening transaction is certainly desirable. In addition, a revised value for the income (option proceeds + dividends - margin interest), in dollars, percent, and annualized percent, is needed. Several indices of the desirability of making the proposed closing option transaction are valuable. First we want to look at the ratio of the income if we make this closing transaction to the income anticipated when we made the opening transaction. Next we want to look at the ratio of the elapsed time since the opening transaction to the elapsed time to expiration anticipated when we made the opening transaction. Finally, we want to look at the ratio of these 2 ratios. Suppose, for example, we find that the income ratio is .87, and the time ratio is only .36. The ratio of these two ratios is 2.4, which means that we have made our profit (in dollars per unit time) at 2.4 times the rate we anticipated at opening time. This parameter may certainly influence

our decision regarding the desirability of making the closing transaction.

Additional data is desired if a total position closeout is being considered. A revised profit (Income + capital gain on stock) is needed, in dollars, percent, and annualized percent. A minor revision is also needed in the ratio indices. Instead of an income ratio, we now need a profit ratio. The time ratio is unchanged, so that instead of the final index being the ratio of the income ratio to the time ratio, it is now the ratio of the profit ratio to the time ratio.

Program Option

Program OPTION has been designed to furnish the output parameters discussed above. Before running, some personalization is required. As supplied, the program computes commissions assuming a 35% discount from the usual rates, and margin interest at 8.5%. Both of these values should be adjusted by the user to meet his needs in accordance with the instructions furnished with the program.

It should be noted that the margin interest is computed by the program assuming that the margin debit is the entire net purchase, not just the percentage marginable under FRB regulations. It has been done this way since an investor with a portfolio large enough to be eligible to trade in options usually has sufficient capital that the current transaction under consideration can and will be put fully on margin. If it is desired to change this, the simplest way is to suitably alter the margin interest rate. For example, to change the margin debit to 50% of net purchase, simply change the interest rate in the program to one half the true interest rate. This is fully discussed in the instructions included in the program.

Before running Program OPTION, some personalization is required.

Following the run command the program will prompt the user to furnish the OPENING DATA. As can be seen in the sample runs further on in this article, the OPENING DATA consists of an identifying stock symbol and possibly a date or other remarks, the number of shares of underlying stock owned, the number of shares to be bought, the difference being in the commission to be charged against the transaction, the stock price, and the dividend expected between opening and expiration. The hedge ratio is also required. Finally, the opening day number, the expiration day number, the option exercise or striking price, and the option premium. The "day numbers" refer to the number of days since the beginning of the year. For example, May 24 is day number 144 (unless it is a leap year). Day numbers may be found in many reference books, such as *The World Almanac*. A table of day numbers is included in this article, see Figure 1. The reader may find it convenient to post it near the keyboard. The author has a master copy which is Xeroxed each year and the option expiration days for that year (the third Friday of each month) are underlined before posting.

The program is set up to handle hedge ratios between zero and infinity, not inclusive.

Following the entry of the OPENING DATA, the program will compute the important parameters of an OPENING TRANSACTION. Note that the income and profit percent-

```

$$$$$ Program OPTION - By A. A. Adler, Ph.D. $$$$$$

$$$$$ OPENING DATA $$$$$$
Stock Symbol, Remarks : SAP - 8/13/79
How many shares owned? 500; and how many bought? 1000
Stock price? 22; and dividend from now to expiration? 250
Hedge ratio (how many calls sold per 100 shares of stock)? .5
Opening day no. 7 200; and Expiration day no. 7 300
Option striking price? 25; and Premium? 2
$$$$$ OPENING TRANSACTION $$$$$$
TIME = .27397 YEARS TO EXPIRATION
STOCK PURCHASED = $2233. STOCK COMMITTED = $33223.
OPTION PROCEEDS = $1441.
NET PURCHASE = $20780. NET LOANED = $31780.
LOWER BOUNDARY = $21.18 PER SHARE : 3.70 & DOWNDOWN
IF OPTIONS EXPIRE
INCOME = $1209. $ = 3.80 $/Yr. = 13.89
[Income = Option proceeds + Dividend - Margin interest]
IF CALLED, STOCK GAIN/LOSS = $4086.
PROFIT = $5295. $ = 16.66 $/Yr. = 60.82
(Profit = Stock gain + "Income")
Do you want to compute a close? YES
$$$$$ CLOSING DATA $$$$$$
Closing day no. 7 250
Option premium? .5; and stock price? 21
Reduced dividend? 125
Do you want to close ALL options or only UNCOVERED ones? ALL
$$$$$ CLOSING TRANSACTION $$$$$$
TIME = .13699 YEARS AFTER OPENING; OPTION PROCEEDS = $1041.
IF ALL OPTIONS BOUGHT BACK
INCOME = $924. $ = 5.91 $/Yr. = 21.23
Ratio of closing income to opening income : .76
RATIO OF CLOSING TIME TO OPENING TIME : .50
RATIO OF INCOME RATIO TO TIME RATIO : 1.53
POSITION CLOSEOUT, STOCK GAIN/LOSS = $-2012.
PROFIT = $-1087. $ = -1.52 $/Yr. = -24.97
RATIO OF CLOSING PROFIT TO OPENING PROFIT : -.21
RATIO OF PROFIT RATIO TO TIME RATIO : -.41
Do you want to compute a close?

```

Figure 2

And now the news...



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Investment, cont'd...

ages are computed on the basis of the NET COMMITTED, not on this basis reduced by the margin debit. In other words, the percent INCOME and the percent PROFIT are percentages of the dollar amount placed at risk, not the dollar amount advanced by the investor. It is a favorite ploy of brokers, even those intelligent enough to know better, to state percent profits to clients in terms of the amount of money the client puts up, as if the money borrowed is not the client's responsibility. This becomes the theatre of the absurd when the client has sufficient securities in his account that he need put up little or no money to make a purchase. If an investor buys \$10,000 worth of stock and puts up only \$100, the remainder becoming margin debit, the stock only needs to rise by

\$100, or 1%, in order for him to double his money according to this way of figuring. No such convenient logic appears in any of these programs.

Note that if the hedge ratio is less than 1, the IF CALLED, STOCK GAIN/LOSS is computed assuming for commission purposes that the only shares sold are those called. The GAIN/LOSS on the remaining shares is computed without commission. The POSITION CLOSEOUT, STOCK GAIN/LOSS, on the other hand, is computed assuming that all shares are sold.

Following the presentation of the OPENING TRANSACTION parameters Program OPTION will ask if a

CLOSING TRANSACTION is desired. If "yes," prompts will be displayed requesting CLOSING DATA. Note that the reduced dividend requested refers to the possible reduction in dividend due to the fact that the time from the opening transaction to the closing transaction is less than the time from the opening transaction to expiration. At this point the user must decide whether he wants to close out "all" options or only those that are "uncovered." Of course, if the hedge ratio is 1 or less, there are no uncovered options and the user must respond with "all" or risk an uncompensated error return. If the user responds with "all," the income information and the profit informa-

```

$$$$$ Program OPTION - by A. A. Adler, Ph.D. $$$$$$

$$$$$ OPENING DATA $$$$$$

Stock Symbol, Remarks : SAV - 8/15/79
How many shares owned? 500; and how many bought? 1000
Stock price? 22; and dividend from now to expiration? 250
Hedge ratio (how many calls sold per 100 shares of stock)? 1

Opening day no.7 200; and Expiration day no.7 300
Option striking price? 25; and Premium? 2

$$$$$ OPENING TRANSACTION $$$$$$

TIME = .7397 YEARS TO EXPIRATION
STOCK PURCHASED = $2223. STOCK COMMITTED = $3223.

OPTION PROCEEDS = $2901.
NET PURCHASE = $19320. NET COMMITTED = $30320.
LOWER BREAK-EVEN = $20.21 PER SHARE = 8.12 % DOWNSIDE

IF OPTIONS EXPIRE
INCOME = $2703. 8 = 8.92 8/YR. = 22.54
(Income = Option proceeds + Dividend - Margin interest)

IF CALLED, STOCK GAIN/LOSS = $3957.
PROFIT = $6660. 8 = 21.97 8/YR. = 80.18
(Profit = Stock gain + 'Income')

Do you want to compute a close? YES

$$$$$ CLOSING DATA $$$$$$

Closing day no.7 250
Option premium? .5; and stock price? 21
Reduced dividend? 125
Do you want to close ALL options or only UNCOVERED ones? UNCOVERED

$$$$$ CLOSING TRANSACTION $$$$$$

SINCE THE HEDGE RATIO IS 1 OR LESS,
THERE ARE NO UNCOVERED CALLS

Do you want to compute a close? YES

$$$$$ CLOSING DATA $$$$$$

Closing day no.7 250
Option premium? .5; and stock price? 21
Reduced dividend? 250
Do you want to close ALL options or only UNCOVERED ones? ALL

$$$$$ CLOSING TRANSACTION $$$$$$

TIME = .13699 YEARS AFTER OPENING; OPTION PROCEEDS = $2100.

IF ALL OPTIONS BOUGHT BACK
INCOME = $2125. 8 = 7.01 8/YR. = 51.15
RATIO OF CLOSING INCOME TO OPENING INCOME = .79
RATIO OF CLOSING TIME TO OPENING TIME = .50
RATIO OF INCOME RATIO TO TIME RATIO = 1.57

POSITION CLOSEOUT, STOCK GAIN/LOSS = $-2012.
PROFIT = $113. 8 = .37 8/YR. = 2.72.
RATIO OF CLOSING PROFIT TO OPENING PROFIT = .02
RATIO OF PROFIT RATIO TO TIME RATIO = .03

Do you want to compute a close?
STOP IN LINE 290
READY
  
```

Figure 3

```

$$$$$ Program OPTION - by A. A. Adler, Ph.D. $$$$$$

$$$$$ OPENING DATA $$$$$$

Stock Symbol, Remarks : SAV - 8/15/79
How many shares owned? 500; and how many bought? 1000
Stock price? 22; and dividend from now to expiration? 250
Hedge ratio (how many calls sold per 100 shares of stock)? 2

Opening day no.7 200; and Expiration day no.7 300
Option striking price? 25; and Premium? 2

$$$$$ OPENING TRANSACTION $$$$$$

TIME = .7397 YEARS TO EXPIRATION
STOCK PURCHASED = $2223. STOCK COMMITTED = $3223.

OPTION PROCEEDS = $5829.
NET PURCHASE = $18394. NET COMMITTED = $23794.
LOWER BREAK-EVEN = $18.26 PER SHARE = 16.99 % DOWNSIDE
UPPER BREAK-EVEN = $31.18 PER SHARE = 41.72 % UPSIDE

IF OPTIONS EXPIRE
INCOME = $5697. 8 = 20.80 8/YR. = 75.91
(Income = Option proceeds + Dividend - Margin interest)

IF CALLED, STOCK GAIN/LOSS = $2439.
PROFIT = $9136. 8 = 33.35 8/YR. = 121.74
(Profit = Stock gain + 'Income')

Do you want to compute a close? YES

$$$$$ CLOSING DATA $$$$$$

Closing day no.7 250
Option premium? .5; and stock price? 21
Reduced dividend? 125
Do you want to close ALL options or only UNCOVERED ones? UNCOVERED

$$$$$ CLOSING TRANSACTION $$$$$$

TIME = .13699 YEARS AFTER OPENING; OPTION PROCEEDS = $5025.

IF UNCOVERED OPTIONS BOUGHT BACK
INCOME = $4960. 8 = 18.10 8/YR. = 132.16
RATIO OF CLOSING INCOME TO OPENING INCOME = .87
RATIO OF CLOSING TIME TO OPENING TIME = .50
RATIO OF INCOME RATIO TO TIME RATIO = 1.74

Do you want to compute a close? YES

$$$$$ CLOSING DATA $$$$$$

Closing day no.7 250
Option premium? .5; and stock price? 21
Reduced dividend? 125
Do you want to close ALL options or only UNCOVERED ones? ALL

$$$$$ CLOSING TRANSACTION $$$$$$

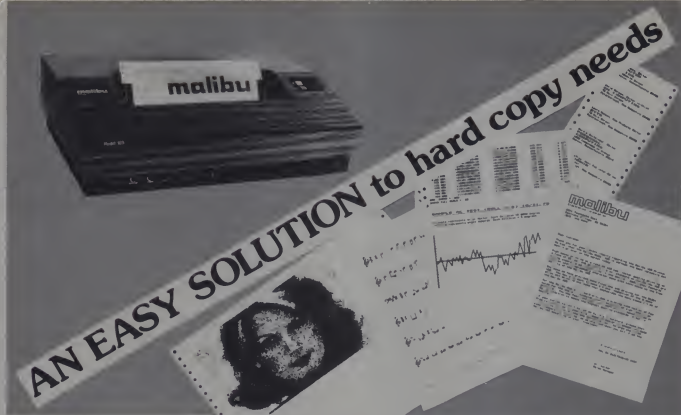
TIME = .13699 YEARS AFTER OPENING; OPTION PROCEEDS = $4222.

IF ALL OPTIONS BOUGHT BACK
INCOME = $4156. 8 = 15.17 8/YR. = 110.75
RATIO OF CLOSING INCOME TO OPENING INCOME = .73
RATIO OF CLOSING TIME TO OPENING TIME = .50
RATIO OF INCOME RATIO TO TIME RATIO = 1.46

POSITION CLOSEOUT, STOCK GAIN/LOSS = $-2012.
PROFIT = $2144. 8 = 7.83 8/YR. = 57.14
RATIO OF CLOSING PROFIT TO OPENING PROFIT = .23
RATIO OF PROFIT RATIO TO TIME RATIO = .47

Do you want to compute a close?
STOP IN LINE 290
READY
  
```

Figure 4



What do you need?

Program listings . . . inventory listings . . . custom logos and letters . . . mailing labels in a multitude of sizes . . . custom forms and the data to complete them . . . curve plotting or bar graphs . . . digitized images from video or bit pads . . . multi-part forms . . . preprinted forms . . . tickets . . . and the list goes on . . .

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Investment, cont'd...

tion, as discussed above, is presented, otherwise only the Income information is given. The program gives the user the opportunity to continuously recompute closing transactions using different data, as long as he pleases.

Sample Runs

As a demonstration of program operation several sample runs are offered. In Figure 2 an opening call transaction with a hedge ratio of .5 is presented, along with a closing transaction. In Figure 3 an opening transaction with a hedge ratio of 1 is presented, along with 2 closing transactions; one in which ALL the options are closed out; the other in which it is attempted to close out only the UNCOVERED options. Note the error return in the latter case. Figure 4 illustrates an opening transaction with a hedge ratio of 2. In this case the closing transactions with ALL the options closed, and with only the UNCOVERED options closed are shown.

Hedging With Calls

Now that we have a program to do all the dog work, let us turn our attention to the writing of calls against stock positions specifically as a hedge. This is not a different strategy, but rather a change in emphasis; a different philosophy. We are now interested in using the call hedge to bias the odds of winning the investment game. We

can use two different strategies; out-of-the-money call writing, and in-the-money call writing. These strategies can be expanded to include puts, of course, and can be made very involved and complex. Brokers like that; it brings in more commissions. It is certainly true however, that the simpler the strategy, the easier it is to *completely* understand and therefore to *completely* control. It is certainly cheaper in terms of commissions. It is extremely easy to get very involved in a many faceted and very complex maneuver, and end up with so many possible alternatives that when the market makes an unexpected turn, which it does just about half the time, utter confusion reigns, and all the beautiful runouts and safety plays which were bought so dearly just don't seem so beautiful anymore. We will discuss the 2 classes of hedges in their simplest form.

Covered call writing was discussed to some extent last month in connection with Program OPGRAPH. Now that Program OPTION is available we are able to examine the strategy in more detail and generate a complete set of real world output parameters.

The Out-Of-The-Money Hedge

The out-of-the-money hedge is easier to understand and certainly easier to accept, and will therefore be presented first. Some time ago the author had 300 shares of NWA, acquired at a price, including commissions, of \$21. per share or \$6300. At that time 3 April 30 calls were sold for \$813, including commissions.

These options had 56 days to go until expiration. As of expiration day, NWA was selling for less than \$30 per share; therefore the option holder did not find it profitable to exercise his options and they expired worthless. A profit of \$880 was therefore realized in 56 days on an investment of \$6300 minus \$813. This comes to 16.04% profit, but since it was made in .1534 years, the annualized profit is 104.56% per year. Note that the stock is still retained. The \$880 profit includes \$11 in reduced margin interest, since the margin debit is reduced by the \$813 option proceeds. For those who do not habitually keep a margin debit, a quick modification to the program will wipe this element out. If the stock had moved above \$30 per share, the profit would of course have been much greater. The complete story is shown in Figure 5.

It is a favorite play of brokers to state percent profits to clients in terms of the amount of money the client puts up, as if the money borrowed is not the client's responsibility.

Meanwhile, 300 more shares of NWA had been purchased at a cost of \$8508, including commission, bringing the total investment to \$14808, or \$24.68 per share. Two and one half months later, NWA was selling for over \$30 per share so 6 October 35 calls were sold for a total of \$1301 including commissions. The data covering the possible outcomes are shown in Figure 6. If the stock simply has the goodness not to fall below \$22.51 per share nothing is lost. In other words, an 8.79% drop in stock price can be withstood before a loss is incurred. If the stock simply remains at \$24.68, a 10.73% profit results. This is 32.93% per year; not bad for a stock that did absolutely nothing for 4 months! If the stock moves above \$35 per share, then, of course, the gravy rolls in.

The In-The-Money Hedge

The out-of-the-money hedge is good when the investor is slightly bullish on the stock, that is, he expects it to at least remain the same or to rise slightly. The in-the-money hedge is better when the investor is

```
000000 Program OPTION - by A. A. Adler, Ph.D. 00000000
00000000000000000000 OPENING DATA 00000000000000000000
Stock symbol, Remarks: NWA - 2/19
How many shares owned? 300; and how many bought? 0
Stock price? 21; and dividend from now to expiration? 56.25
Hedge ratio (how many calls sold per 100 shares of stock)? 1
Opening day no. 7 50; and Expiration day no. 7 106
Option striking price? 30; and Premium? 2.6125
00000000000000000000 TRANSACTION 00000000000000000000
TIME = .15342 YEARS TO EXPIRATION
STOCK PURCHASED = $0. STOCK COMMITTED = $6300.
OPTION PROCEEDS = $813.
NET PURCHASE = $-813. NET COMMITTED = $5487.
LOWER BREAK-EVEN = $18.29 PER SHARE : = 12.91 % DOWNSIDE
IF OPTIONS EXPIRE
INCOME = $880. S = 16.04 R/YR. = 104.56
(Income = Option proceeds + Dividend + Margin interest)
PROFIT = $3472. S = 63.29 R/YR. = 412.49
(Profit = Stock gain + Income)
Do you want to compute a close?
```

Figure 5

Investment, cont'd...

neutral, that is, he expects it to remain about the same. The reason for this is that in-the-money calls have a higher premium than out-of-the-moneys. An out-of-the-money call has only time value, that is, the value of hope, the value induced by the possibility that the premium might rise before expiration time. In-the-money calls however, have intrinsic value in addition to time value. A call exercisable at \$10 is worth no less than \$2 if the underlying stock is selling at \$12 per share, for example, since the buyer can call the stock at \$2 per share less than the market price. These and other considerations will be discussed more fully next month when option premiums are studied in some detail.

As an example of an in-the-money call write, consider the following maneuver. On June 17, 1000 shares of HJ were bought for \$12.75 per share. At the same time, 10 January 10 calls were sold. The reader is now wondering whether or not there is a misprint in the article. Stock was bought at \$12.75 per share but calls were sold giving the buyer of the calls the right to grab the stock for \$10 per share. How can you make money if stock is relinquished at less than cost? Very simply: when the cost of the privilege is greater than the loss on the stock, after all commissions are paid. In this case the cost of the privilege, which is of course the option premium, is \$4.125 per share. This large value is due to the fact that the intrinsic value alone is \$12.75 minus \$10 or \$2.75 per

share. The difference, or \$4.125 minus \$2.75, is the time value of the option, \$1.375 per share.

The complete transaction is presented in Figure 7. Note that although \$12915 worth of stock was bought, only \$8878 was required. This is a considerably larger discount than was obtained when out-of-the-money calls were sold. Note further the large amount of downside protection that is obtained in this type of

The program gives the user the opportunity to continuously recompute closing transactions using different data, as long as he pleases.

maneuver. The stock can slide from \$12.75 per share to \$8.88 per share, a drop of 30.37% before a loss is incurred. If the stock remains above \$10 per share the calls will expire worthless and a profit of 44.2% will be realized in 7 months. This works out to an annualized return of 75.4%. This is not a bad return on a stock that does not go up at all. If, on the other hand, the stock drops to \$10 per share, that is by 27.5%, the calls are exercised and still a 9.71% profit is made. In this case the annualized rate is 16.55% which is not too hard to take for a stock that lost 27.5% of its value.

There always seems to be something very fishy about the in-the-money call write. However, if the

reader who has never been exposed to this maneuver before will take the trouble to examine it very closely, he may find that he has latched on to something not only very interesting, but potentially quite profitable.

Conclusions

Call writing against already existing or concurrently established stock positions is more conservative and at the same time more profitable than simple long stock positions. It is therefore not surprising that it is also by far the most popular option hedging strategy. As is the case with all option strategies however, proposed positions must be examined carefully since both the opportunity for profit and the risk are sensitive to the variables and the commissions. Also as before, the calculations are long and tedious, especially when commissions are included; and they must be since commissions will often change an otherwise profitable maneuver into a losing venture. Program OPTION allows the user to perform such calculations quickly and easily, and permits the examination of a large number of possible maneuvers in a short time.

Program OPTION, along with OPGRAPH, presented last month, and the other 2 programs to be presented, is currently available on cassette for the TRS-80 16K Level II from Creative Computing Software, and on North Star disk, either single or double density, from the author. An Applesoft version is currently being written, and it is anticipated that other versions will be made available in the near future. □

```

$$$$$ Program OPTION - by A. A. Adler, Ph.D. $$$$$$

$$$$$ OPENING DATA $$$$$$

Stock Symbol, Remarks : HJ - 6/18
How many shares owned? 0; and how many bought? 0
Stock price? 24.48; and dividend from now to expiration? 12.75
Hedge ratio (how many calls sold per 100 shares of stock)? 1
Opening day no.7 14; and Expiration day no.7 288
Option striking price? 35; and Premium? 2.25

$$$$$ OPENING TRANSACTION $$$$$$

TIME = .32603 YEARS TO EXPIRATION
STOCK PURCHASED = 80. STOCK COMMITTED = $14808.

OPTION PROCEEDS = $1301.
NET PURCHASE = $-1301. NET COMMITTED = $13507.
LOWER BREAK-EVEN = $22.51 PER SHARE ; = 8.79 % DOWNSIDE

IF OPTIONS EXPIRE
INCOME = $1450. S = 10.73 S/YR. = 32.93
(Income = Option proceeds + Dividend - Margin interest)

IF CALLED, STOCK GAIN/LOSS = $5992.
PROFIT = $7442. S = 35.10 S/YR. = 169.01
(Profit = Stock gain + 'Income')

Do you want to compute a close?
  
```

Figure 6

```

$$$$$ Program OPTION - by A. A. Adler, Ph.D. $$$$$$

$$$$$ OPENING DATA $$$$$$

Stock Symbol, Remarks : HJ - 6/17
How many shares owned? 0; and how many bought? 1000
Stock price? 12.75; and dividend from now to expiration? 330
Hedge ratio (how many calls sold per 100 shares of stock)? 1
Opening day no.7 172; and Expiration day no.7 21
Option striking price? 10; and Premium? 4.125

$$$$$ OPENING TRANSACTION $$$$$$

TIME = .58610 YEARS TO EXPIRATION
STOCK PURCHASED = $12915. STOCK COMMITTED = $12915.

OPTION PROCEEDS = $4037.
NET PURCHASE = $8878. NET COMMITTED = $8878.
LOWER BREAK-EVEN = $8.88 PER SHARE ; = 30.37 % DOWNSIDE

IF OPTIONS EXPIRE
INCOME = $3925. S = 44.20 S/YR. = 75.40
(Income = Option proceeds + Dividend - Margin interest)

IF CALLED, STOCK GAIN/LOSS = $-3063.
PROFIT = $862. S = 9.71 S/YR. = 16.55
(Profit = Stock gain + 'Income')

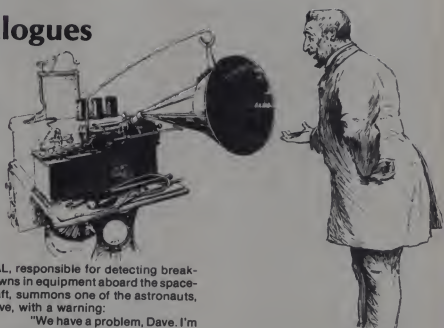
Do you want to compute a close?

SYE
  
```

Figure 7

Computer Mechanisms for Man-Machine Dialogues

Robert Branchek



The capability of computers to form intelligent answers to a human interrogator's questions has frequently astonished those unfamiliar with machine architecture and programming. Such surprise and awe are quite understandable, for some of the dialogues do appear indistinguishable from human conversations. An examination of several of these interactions

— including comparisons among fictitious man-machine dialogue, actual people-computer dialogues, (and, implicitly, dialogues among humans) — should enable us to understand the nature of computer mechanisms.

When a keyword is not found in a sentence, Eliza must rely on generalized answers, such as "Tell me more" or "i see," which are acceptable answers to almost any input phrase.

Idealized computer interactions with humans have often been depicted in recent films. For example, in Stanley Kubrick's *2001*, a film based on the novel by Arthur C. Clarke, HAL, a bastardized IBM computer, controls the entire operation of a manned spaceship exploring the outer planets.

*Go back one in the alphabet from each letter of IBM and you got HAL.

Robert Branchek, DEC, One Penn Plaza, New York, NY 10001.

HAL, responsible for detecting breakdowns in equipment aboard the spacecraft, summons one of the astronauts, Dave, with a warning:

"We have a problem, Dave. I'm having difficulty maintaining contact with Earth. The trouble is in the AE-35 unit. My fault prediction center reports that it may fail within 72 hours."

Dave asks, "What procedure do you suggest?"

HAL replies, "The best thing would be to replace the unit with a spare so that we can check it over."

In this example, the discourse between HAL and Dave is in no way perceptibly different from a conversation between two men. HAL and Dave effectively communicate information. The computer appears to understand Dave's inquiries, and Dave in turn appears to understand HAL's answers. (And, although it is not evident from the sample dialogue, the converse is also true — Dave can understand and answer HAL's requests.)

Actual dialogues between a machine and a person can also be indistinguishable from real conversation between people.

Analysis of an actual dialogue between a person with a computer program may provide some clues as to the mechanism of computer conversation. The program was written by Joseph Weizenbaum of M.I.T., and is named "Eliza" after George Bernard Shaw's character Eliza Doolittle (who is taught to speak correct English in the play *Pygmalion*). In the following sample, the program "talks" with a person who complains that "Men are all alike":

Person: Men are all alike.

Computer: In what way?

Person: They're always bugging us about something or other.

Computer: Can you think of a specific example?

Person: Well, my boyfriend made me come here.

Computer: Your boyfriend made you come here?

In spite of its simplistic mechanism, Eliza can be quite convincing in holding a conversation. As a therapist, Eliza is free "to assume the pose of knowing almost nothing of the real world."

Person: He says I'm depressed much of the time.

Computer: I am sorry to hear that you are depressed.

Person: It's true. I am unhappy.

Computer: Do you think that coming here will help you not to be unhappy?

Person: I need help, that much seems certain.

Computer: What would it mean to you if you got some help?

Person: Perhaps I could learn

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Countdown	Roadrace
Cup	Rotate
Dealer's Choice	Safe
Deepspace	Scales
Defuse	Schmoo
Dodgem	Seabattle
Doors	Seawar
Drag	Shoot
Dr. Z	Smash
Eliza	Strike 9
Father	Tennis
Flip	Tickertape
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Here is the sequel to the best-selling book "Basic Computer Games."

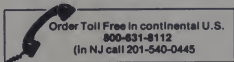
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Dialogues, cont'd...

to get along with my mother.

Computer: Tell me more about your family.²

The difference between this dialogue and the one between Dave and HAL is that here the questions are typed on a typewriter-like device, a teleprinter, which inputs information to the computer, and the answers are returned on the same device. Eliza seemingly "understands" what is typed. Words are easily recognized by the computer, since they are merely unique sequences of symbols (which we call letters) set off by spaces. *

It finds a match in the word "alike." Its next instructions are to print "In what way?"

In the Eliza program, the computer retains a list of words of high information value, termed "keywords," and executes instructions which compare these keywords with each word in the typed-in sentence. For example, in the first sentence it compares all the words with its list until it finds a match. In our sample, it finds a match in the word "alike." Its next instructions are to print "In what way?" because it found a match for the appropriate keyword. The person who has selected the instructions — Joseph Weizenbaum — has of course assumed that "In what way?" will always be an acceptable response to a sentence in which "alike" appears. A further example of this mechanism is provided by the next sentence, "They're always bugging us about something or other," in which the instructions find a match for "always," whereupon the perfectly reasonable response "Can you think of a specific example?" is returned. The validity of the response once a keyword is found determines the effectiveness of the dialogue.

Instructions must be present which determine what to print when a keyword is not found, as well as when one is found. For example, in the third sentence, "Well, my boyfriend made me come home" it finds no keywords.

²Though it is possible to exchange information verbally with the computer by using an electronic voice and speech recognition unit, present man-machine dialogues are not usually conducted on auditory channels. This, however, is the only principal difference between actual computer conversations with men and fictitious ones. But since our interest in this discussion is not along which channel we can communicate, but in the underlying mechanism which makes communication possible, we may consider this difference superfluous.

Its instructions, when no keywords are found, are to print back the sentence with exclamations discarded (exclamations are defined as one or two words at the beginning of the sentence followed by a comma), the appropriate personal pronouns substituted, and a question mark replacing a period at the end. These instructions produce a response to the third sentence of "Your boyfriend made you come here?"

It is this simple matching and substitution process that produces, in response to the statement by the woman that she is depressed, the computer's statement, "I am sorry to hear that you are depressed." The instructions have found a match for "depressed," substituted you for I, added "I am sorry to hear that..." and have discarded other unnecessary words to produce, "I am sorry to hear that you are depressed."

Additionally, Eliza's mechanism will return responses to any input sentence. Although it is not shown in the sample dialogue, when a keyword is not found in a sentence, Eliza must rely on generalized answers, such as "Tell me more" or "I see," which are acceptable answers to almost any input phrase.

Though Eliza usually returns appropriate responses, inappropriate ones can occur because of the simplicity of Eliza's mechanism. For example, if the woman in the sample dialogue had typed in the phrase, "My rock is depressed," Eliza's response would have been, "I am sorry to hear that your rock is depressed." Eliza doesn't really "consider" the meaning of more than one word in a sentence; hence, Eliza is unable to "recognize" that rocks don't get depressed, only people get depressed. All Eliza does is find certain words in a sentence or phrase, rearrange them, and print back an answer.

In spite of its simplistic mechanism, Eliza can be quite convincing in holding a conversation. According to Weizenbaum, however, this can be attributed to the mode of conversation. As a therapist, Eliza is free "to assume the pose of knowing almost nothing of the real world."³ Its answers are only convincing in the restricted context of psychoanalysis, with Eliza serving in the role of a therapist — ignorant of the world, and able to respond only in terms that often function to solicit further responses from the speaker. Unlike the dialogue in 2001 between HAL and the astronaut Dave, no requests for concrete information can be answered by Eliza, or a program like it. Another mechanism must be used by a program if specific information is to be returned.

One of the first programs to use

such a mechanism was developed at M.I.T. in 1960. Named "Baseball," it can be asked information about baseball games played in the American League, in one season of play. Baseball can return correct answers to questions such as, "Whom did the Red Sox lose to on July 5?" or, "How many games were played by the Yankees in the month of August?" Baseball could work as the ultimate commentary companion for a play-by-play radio announcer like Phil Rizzuto, the announcer for The New York Yankees, answering such complex questions as, "Did every team play at least once in each park in each month?"⁴

"Parry" functions as a patient — a paranoid — rather than a therapist. Its mechanism of understanding consists of several stages of processing.

The mechanism used by Baseball is essentially a large cross-referenced list containing the month, day, place, teams, and score of every baseball game played in one league, throughout an entire season. Unlike Eliza, Baseball can provide specific information in response to a request. However, it can only answer questions to which it has information — baseball in the American League for one specific year. So, like Eliza, its "world" is restricted. Its mechanism searches input requests for the keywords it can "understand," i.e., months, days, years, teams, runs, ballparks, and scores. Once the keyword in a sentence is found, it looks up the matching information contained in its list, and returns an answer. Its mechanism is not appreciably different from Eliza's, except that it can return specific information.

Another program, Student, provides a third example of a mechanism for carrying on an exchange of information. Student, developed by Brobrow at M.I.T. in 1964, can be asked to solve algebraic problems with a level of difficulty at approximately the high school level. For example, it can solve the following problems:

If the number of customers Tom gets is twice the square of 20 percent of the number of advertisements he runs, and the number of advertisements he runs is 45, what is the number of customers Tom gets?

Mary is twice as old as Ann was when Mary was as old as Ann is now. Mary is 24. How old is Ann?

Dialogues, cont'd...

The mechanism which Student uses to solve such problems is similar to those used by Eliza and Baseball: it looks for the keywords which it finds a match for in its list, and then replaces them, in order to solve the problem. However, unlike Eliza or Baseball, it substitutes variables, arithmetic operators, or constants for the keywords it finds. For example, the second problem is translated by substitutions into, "Mary's age is 2 times Ann's age K years ago; K years ago Mary's age was Ann's age now; Mary's age is 24, X is Ann's age." This is next translated, again by substitution, into the following set of equations:

$$M=2(A-K)$$

$$M-K=A$$

$$M=24$$

$$X=A$$

with M replacing Mary, A replacing Ann, and the expression 2(A-K) equaling Mary's age. Any related problems can be solved in the same way.⁵

Parry will also replace any letter with a letter that is near it on the keyboard of the teletypewriter to correct errors like "dront" for "front."

The input to Student, like Baseball, contains a specific question, and a request for an answer, the solution to the problem. Unlike Baseball, requests made to Student contain the data, rather than the data being stored internally in the program. Student has only limited "knowledge," such as the number of the feet in a larger unit, the yard (a yard contains three feet), or basic relationships (like "distance equals velocity times time.")⁶

Mechanisms such as those used in Eliza, Baseball and Student would have difficulty with some requests because of two problems: the different meaning a word may have dependent upon its position in a group of words, and the different meaning a word may have independent of its sentence position. For example, if I pose the following question to Student — "If Veronica is taller than Susan and Susan is taller than Carol, what is the relationship between Veronica and Carol?" — Student can easily "recognize," or find a match for the key phrase, "taller than." It can then substitute a "greater than" symbol, >, which is used to represent a mathe-

matical relationship which is written easily as a set of instructions. Student will also substitute variables for Veronica, Susan and Carol, forming an expression, "A > B > C", then, since the variables are ranked, it will also "recognize" that A must be greater than C. Student could then translate the variables A and C back to Veronica and Carol respectively, and the greater-than symbol back to taller than," and return the answer, "Veronica is taller than Carol."

However, a program like Student would have great difficulty with the following question, "If nothing is better than a good square meal, but a sandwich is better than nothing, what is the relationship between nothing and a sandwich, and nothing and nothing?" The phrase "is better than" can, like "is taller than," be replaced with the "greater than" symbol, and "nothing," "a good square meal," and a "sandwich" can all be replaced by variables. However, using the mechanism just described, Student will return to answer, "Nothing is better than a sandwich and nothing is better than nothing."

While some people may believe these assertions — those who like sandwiches and those who like nothing — such illogical or incorrect answers occur because of the meanings of the word "nothing" in the example. In its first context, "nothing" means "there isn't anything else that"; in its second usage means, "not anything else." Student does not contain the required instructions for dealing with the multiple meanings of a word, even when its meaning could be determined by its position in a sentence.

How difficult this problem can be is best illustrated by the sentence, "Time flies like an arrow," which can have at least four different meanings. Without changing the order of the words in the sentence, the following are four interpretations of what the sentence means:

1. Time moves in the same manner that an arrow moves.
2. Measure the speed of flies in the same way that you measure the speed of an arrow.
3. Measure the speed of the flies that resemble an arrow.
4. A particular variety of flies called "time flies" are fond of an arrow.⁸

An analysis of individual words in the different interpretations shows that time, in the first interpretation, can be understood as a noun; in the second and third interpretations, as a verb, to measure along the axis of time; and in the last interpretation, as part of a compound word "time flies" — seem-

ingly a species of fly. The word "like" is used for comparisons meaning "in the same way" or "that resemble" in the first three interpretations, and means "caring for," or "fond of," in the last interpretation.⁹

Programs which "consider" the several possible meanings of a word in a sentence must use other sources of information to form an appropriate response. For example, a program's mechanism could use the group of words that surround a keyword to find its meaning. For example, in the sentence "John hit the ball with a bat," some words serve to explain how John, a ball, and a bat relate to the word hit. A program attempting to discover the meaning of the sentence, over and above merely the keywords, must "recognize" that John performs the action of hitting, that he does it to the ball, and that he uses the bat as a tool.¹⁰

"See red" is "understood" by Parry as identical in meaning to "become angry." "Emergency Room" is recognized as hospital."

A second way a program can ascertain the meaning of both a keyword and the major idea of the sentence is to look at the way each word is used in the sentence. The programmer, as the person who selects the instructions which determine how the mechanism of the program works, must first choose a group of words with similar characteristics, decide in what way they may be used for different meanings, and then locate other keywords which help to signal how the first word of a group of words is being used.

In the sentence, "John hit the ball with a bat," "John," "ball" and "bat" are all nouns. As in many sentences, the meaning of the sentence focuses around these nouns; the remaining words serve to show how "John," the "ball" and "bat" relate to one another. In this example, the word "with" indicates that the last noun, bat, is used as a tool by the noun that precedes it in the sentence, John.

In another example, "Mary went from the library to the bakery," the word "from" signals that the word "library" is used as an initial position, a place "from where" a noun which occurs earlier in the sentence, "Mary," is coming. The word "to" signals that the noun that follows it in the sentence, "bakery," is the destination where Mary will end up.

Dialogues, cont'd...

The word "for" in a sentence usually indicates a beneficiary — "for whom" some action is being performed, as in "Harold bought the lamp for Gertrude" or it can indicate duration, as in the sentence, "Louis had been at his desk for one hour." The word "by" causes the action to occur, for example, "Carol was kissed by Bob," or a container or means, as in "Herman always travels by train," or a location, as in "Jeffreys placed his shoes by his bed."¹¹

Often, however, neither these words by themselves nor any reliable "signal" words are sufficient to resolve ambiguities in the meaning of the words in a sentence.

The first sentence typed, "Men are all alike," is answered by Eliza, "In what way?"

Ambiguity is particularly bad among verbs, the words that explain the type of activity occurring in a sentence. Fortunately, the position and the meaning of a noun tends to work together with the verb to resolve ambiguities about the meaning of each, even if "signal" words are absent. For example, in the sentence "Paul shot a picture," "picture" aids in determining the meaning of the action "shot" — presumably the tripping of the shutter of a camera; though it is possible but highly improbable that Paul shot a picture by pointing a gun at it and firing.

Other words can serve to define the meanings of words, such as verbs, in a sentence. In the sentence, "He threw away the food," the word "away" indicates that the food was discarded. This sentence has an entirely different meaning from the same sentence with "away" removed: "He threw the food," meaning he propelled the food through the air to an unspecified destination.¹²

A program can get other clues about word meaning from the position of the word in the sentence. Consider again "John hit the ball with the bat." A noun which occurs early in a sentence, like "John," frequently is used as the initiator of an action, while a noun which occurs later is frequently the recipient of the action, like "ball," or a tool, like "bat." While this is not always true, it can still help to assess the meaning of words in a relatively simple sentence.

Many combinations of words have unique meanings when they occur

together, different from their meanings separately — in particular, idiomatic expressions like "eat up." Such expressions, recognized by a program, can help it "understand" the meaning of a phrase.

Using all these sources of information, it is possible to develop a more sophisticated mechanism than those used by Eliza, Baseball or Student for analyzing sentences. One of the best programs developed which can "understand" English text is a program called "Parry" which, unlike Eliza, functions as a patient — a paranoid — rather than a therapist. Its mechanism of understanding consists of several stages of processing, in which the input text is gradually transformed.

In the first stage of processing, all lower-case characters are converted to upper case because lower-case letters add little information value to the meaning of a word. In addition, other characters such as asterisks, which may have been inadvertently typed, are discarded. Finally, irregular spacing among words and punctuation is removed.¹³

In the second stage, each word is looked up in a dictionary list. If a match is found, Parry takes note of it for use in further processing phases, and continues to analyze the remaining words. If the word is not found, a second list of frequently misspelled words is consulted; if the word appears here, it is replaced by its correct spelling.

If the word is still not found, the trailing letters of the word (the last one, two, three, or four letters) are compared against a list of possible suffixes. Contractions are replaced by fully spelled-out words after comparison with a fourth dictionary list of words that accept contractions, e.g., don't, I'm, you're, etc. Suffixes which can change the meaning and function of a word are also analyzed. For example, the usual meaning and function of the words "agree" and "harmony" are "known" to the program. If the suffix "ize" is added to "harmony," an analysis shows that the resultant word "harmonize" now means "agree." A similar mechanism works with prefixes attached to words.¹⁴

If a word is not yet matched, it is now treated as a typing mistake. Parry will try several manipulations of the word to correct it and then run it through the list again. For example, Parry will selectively delete any double letter from a word to correct misspellings like "until" for "untill," and reanalyze the resulting word. Or it will transpose adjacent letters, to correct errors like "conceive" for "conieve." Parry will also replace any letter with a letter that is near it on the keyboard of the teleprinter — the device used to

communicate with Parry — to correct errors like "dront" for "front." (The letter "d" and "f" are next to each other on the keyboard.) Finally, in a last attempt to correct misspellings, Parry will split a word into two words, trying all combinations of letters to correct for errors like "tothe" for "to the." If a word is not "recognized," it is deleted from the sentence.

Because computer programs run fast, all of these comparisons of words against one or more lists can be made rapidly. Successive phases of analysis of the text can also be done rapidly. Thus what would seem an impossibly tedious task for a person, the comparison of all the words of a sentence against several lists of words, is done easily by a program.

Parry contains a mechanism that uses not only the structure of input sentences but the meaning of most of the words of the sentence and often the meaning of the sentence itself.

The next step in the analysis performed by Parry is an attempt to deal with groups of words whose meanings cannot be determined by the individual words. These are the idiomatic expressions such as, "make up with," which is replaced by Parry with "reconcile with," or "see red," which is "understood" by Parry as identical in meaning to "become angry." Other idiomatic expressions such as "go to pieces," which is translated "to crumble," are also recognized as similar in meaning to words contained in one of Parry's lists.¹⁵ Compound words, such as "Emergency Room," which is recognized as "hospital," are recognized and replaced in the same manner.

Words which act as verbs, i.e., words which indicate what type of action is occurring, are examined to find what tense they are in, i.e., when the action occurs. The program does this by looking at the endings of verbs, the last two or three characters.

Finally, the program determines how the meaning of the input sentence relates to its "world." In this respect, Parry is similar to the earlier programs. However, Parry will "recognize" questions that are outside of its world and will attempt to output answers that will return the topic of the conversation back to what it "understands." A sample of a dialogue with Parry should

Dialogues, cont'd...

serve to illustrate the result of its translation process. In the following sample, "I" labels the words of the person who is talking to the program and "P" labels the responses of Parry, the program:

- I: What's your name?
P: Pat Smith.
I: Patrick or Patricia?
P: I'm a man. (Parry "recognizes" that Patrick is a male.)
I: How old are you?
P: Twenty-eight. (Both misspellings are corrected.)
I: Why are you here?
P: I'm somewhat upset.
I: Have you dreamt any strange dreams?

P: I don't remember any dreams. (Parry "sees" the tense of the verb "dreamt" and changes it to a noun "dream" in forming a response.)

(Later in the dialogue)

- I: Don't you like being here?
P: No. (Parry "understands" the reversal of the noun and verb in the question — forming an interrogative — and forms a correct response.)
I: Being in the hospital might do you a lot of good.
P: It's not helping me much to be here. (The idiomatic expression "do" — phrase with a noun — "good" is "understood.")

(Later in the dialogue)

- I: Do you want to get a pair of socks for Christmas?
P: I want to be out of here. (Parry "recognizes" the meaning of the sentence as being out of its world and categorizes it as a frivolous question. Parry produces an answer which relates to its own world.)
I: Could you tell me the name of the first president of the United States?
P: Babe Ruth. (Parry again "recognizes" the question as being apart from its world and, according to its instructions, returns a humorous answer.)
I: When did you first learn that you were crazy?
P: I don't want to talk to you any more, buzz off.

(Parry responds to the keyword "crazy" in producing this response.)
(Later in the dialogue)

- I: What are you going to be doing at the same time of day tomorrow?
P: I'll be here on the ward. (It "understands" the complex verb phrase and forms its response.)
I: Bye, Pat.
P: Goodbye.¹⁶

In a comparison of Parry with Eliza, Baseball and Student, Parry is easily the best example of a program that "understands" sentences and phrases. Parry contains a mechanism that uses not only the structure of input sentences but the meaning of most of the words of the sentence and often the meaning of the sentence itself. Clearly, Parry comes closest to the idealized fictitious dialogue between a person and a computer, Dave and HAL respectively, in 2001.

Parry will "understand" only information about its own "world" and very little about anything else.

The mechanisms of the programs Eliza, Baseball and Student are based predominantly on the syntax of the English language and the meaning of one keyword per input. Although these programs can seemingly carry on a conversation, none can do so as effectively as Parry. Eliza will not answer requests for concrete information; and although Baseball and Student answer such requests, their mechanisms do not allow for the varied responses returned by Parry. Not unexpectedly, Parry is the most recently written of the four programs, and represents the present state of development for mechanisms producing man-machine dialogues.

Although the mechanism used by Parry seems complicated when compared with the mechanisms of Eliza, Baseball or Student, it is still limited. Parry will "understand" only information about its own "world" and very little about anything else. This should not suggest, however, that more complicated mechanisms cannot be developed in the future. Samuel Butler, in the nineteenth century, recognized this when he wrote, "There is no security against the ultimate development of mechanical consciousness in the fact of machines possessing little consciousness now."¹⁷ Indeed, even now, dialogues between men and computers are, in many instances and respects, not recognizably different from dialogues between people. □

Footnotes

1. Arthur C. Clarke, 2001: A Space Odyssey. (New York: Doubleday & Co., Inc., 1962, Avon Books, 1970), p. 171.
2. Joseph Weizenbaum, "Eliza-A computer program for the study of natural language communications between man and machine," *Communications of the Association for Computing Machinery*, Vol. 9, No. 1, pp. 36-37.

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4. Bertran Raphael, *The Thinking Computer: Mind inside Matter*. (San Francisco: W. H. Freeman, 1976), p. 194.

5. D. G. Brobbow, Quoted in Bertran Raphael, *The Thinking Computer: Mind inside Matter*. (San Francisco: W. H. Freeman, 1976), p. 195.

6. Bertran Raphael, *The Thinking Computer: Mind inside Matter*. (San Francisco: W. H. Freeman, 1976), p. 196.

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8. Ibid., p. 186.

9. Ibid., p. 186.

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11. Patrick Henry Winston, *Artificial Intelligence*. (Manito Park, Calif.: Addison-Wesley Pub. Co., 1977), p. 72.

12. Ibid., p. 79.

13. Roger C. Parkinson, Kenneth Mark Colby, & William S. Fought, "Conversational language comprehension using integrated pattern-matching and parsing," *Artificial Intelligence* Vol. 9, p. 116.

14. Ibid., p. 117.

15. Ibid., p. 118.

16. Ibid., pp. 131-132.

17. Samuel Butler, Quoted in Donald G. Fink, *Computers and the Human Mind*. (Garden City: Doubleday & Co., Inc., 1966, Anchor Books, 1966), p. 206.

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"It can't actually think, but when it makes a mistake, it can put the blame on some other computer."

The Psychic Boom

Hubert L. Dreyfus
and
Stuart E. Dreyfus

A senior scientist [recently] noted that technology was passing man by. The operator could no longer process and input information fast enough to keep up with his onboard central processors... He could not react at the rates required by his systems!

I ask students to stand at net in the volley position, and then set the machine to shoot balls at three-quarter speed... At first the balls seem too fast for them, but soon their responses quicken. Gradually I turn the machine to faster and faster speeds, and the volleys become more concentrated. When they are responding quickly enough to hit the top-speed balls and believe they are at the peak of their concentration, I move the machine to midcourt, fifteen feet closer than before. At this point students will often lose some concentration as a degree of fear intrudes. "Relax your mind... Let it happen." Soon they are again able to meet the ball in front of them with the center of their rackets. There is no smile of self-satisfaction, merely total absorption in each moment. Afterward some players say that the ball seemed to slow down; others remark how weird it is to hit balls when you don't have time to think about it!

While man's technology, it seems, may be overtaking his capacity to think, it may not yet have even approached a skilled performer's ability to act. Such action faster than thought is not only a necessity when dealing with high-technology systems but even when there is time for thought the ultimate level of master performance is reached only by

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quieting the analytical mind.

This highest level of performance is reached by passing through a series of quite distinct stages.¹ The novice jet pilot focuses all attention on a list of memorized procedures to be applied in terms of specific context-free features which could be recognized by any objective observer. In doing so, he is so absorbed in details that he is unaware of surrounding events, and he experiences no sense of flying.



Courtesy of McDonnell Douglas

With further experience the trainee acquires the ability to recognize such situations as being in the landing envelope and such sensations as the accelerational forces, characteristic sounds and vibrations and learns their importance. He analytically determines his actions by applying maxims such as "determine whether the aircraft is in the landing envelope,"² return to base when vibrations are abnormal, etc. This intermediate student pilot begins to feel that he is flying the plane.

Finally, a pilot's repertoire of flying experiences becomes so extensive that each whole current situation is recognized as similar to a previous typical situation (paradigm);³ and this previous situation elicits a remembered appropriate response. Furthermore, associated with each of

these paradigms are other paradigms. Each of these associated paradigms are ones to which the original situation might typically be seen as similar should the salient aspects of the current situation not be what the current paradigm would lead one to expect. For example, suppose that the current situation is a normal landing, and hence location in the center of the landing envelope is a crucial aspect. If the pilot perceives that he is very high in the landing envelope, the associated paradigm in terms of which he might see himself is a "go around" situation. The analytic mind has been completely bypassed in the production of performance and replaced by a holistic and intuitive mode of response. The pilot now has the experience that he is flying.

The same tri-partite phenomenon shows up whenever a person acquires a complex skill, be it highly intellectual like chess, or largely physical like tennis. For example, in chess a beginner learns simple rules involving context-free features, such as to trade pieces so as to maximize material balance (calculated by adding up the values of the individual pieces involved). In tennis, a player first learns context-free movements such as transferring his weight from one foot to the other while making a stroke.

With experience, a chess player learns to follow maxims such as "exploit a weakness on the king's side" or "avoid an unbalanced pawn structure." (There are, of course, no objective rules by means of which a novice could determine whether the pawn structure was unbalanced or the king's side weak.) And in tennis an experienced player may be advised to use top-spin on his lob.

When truly proficient, a chess master, immersed in the world of the game, immediately perceives the forces and tensions on the board as



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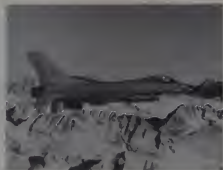
Psychic, cont'd...

similar to those previously experienced in actual play or in the involved study of previous games. The highly skilled tennis player no longer thinks about using top-spin or applying other maxims, but, by-passing his analytical mind, he enters into the rhythm of the game.⁵

We're interested here in the various roles that the analytical mind, once it has been by-passed in the production of performance, can take vis-a-vis highly proficient activity.

In order to perfect the intuitive mind's paradigms, and in some cases even to improve its current performance, the analytical mind can review and improve the two associative functions of the paradigms. At the simplest level, it can assess how well the action associated with each paradigm enables the proficient performer to cope with each situation. For example, during air-to-air combat a highly proficient pilot's analytical mind might be assessing the appropriateness of maneuvers. If the analytical mind senses that the instantaneous intuitive responses are indeed appropriate, the pilot feels with euphoria that he is ahead of the plane. If inappropriate, there is uneasiness and the pilot feels that he is lagging behind the plane.⁷

In this latter case, the analytical mind shifts to monitoring the second associative function of paradigms. Assuming an experienced performer with an adequate repertoire of appropriate paradigms, one reason a whole sequence of actions based on a series of paradigms can fail to cope adequately is that the associative function which replaces one paradigm by another when the former



Courtesy of General Dynamics

To see what the analytical mind can do to get the intuitive mind back on the track, consider the following. If the intuitive mind is seeing the Necker cube in Figure 1 as a cube with vertex A in the nearest face and vertex B in the farthest face, the analytical mind can sometimes reverse the cube by focusing on vertex B. This makes vertex B salient, and the intuitive mind, if it is not hopelessly locked in the old Gestalt, will move the farthest face to the foreground, and the cube will reverse.

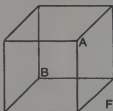


Figure 1

In general, when the intuitive mind is perseverating in what might be an inappropriate set, the analytical mind can focus its attention on aspects of the current situation which are inessential viewed under the current paradigm. The intuitive mind can then either ignore these aspects or it can see the situation in terms of a different paradigm in which these aspects are crucial. Thus a pilot, in air-to-air combat with an adversary whom he deems to be of equal experience, may, after experiencing a sequence of actions as inappropriate, analytically entertain the hypothesis that his adversary is much less experienced than he supposed, and thus focus on aspects of the engagement he had not previously noticed. This may cause him to see events in a different light, and if his actions become more appropriate he will have learned to respond to such a possibility the next time he encounters a similar situation.

We have seen that there are two important types of monitoring functions performed by the analytical mind while the intuitive mind is

engaged in the production of skilled performance: it can monitor the appropriateness of the actions to the situation and thereby improve performance in the future, or it can monitor the overall sense of the situation produced by the sequence of paradigms guiding the intuitive mind and can focus on aspects that the current paradigms lead the performer to overlook. We shall now see that the analytical mind can function in two other *nonmonitoring* modes. First, and most obviously, when the intuitive mind has completely taken over current skilled performance, the analytical mind is freed to engage in other tasks. Experienced drivers easily carry on conversations while still performing proficiently. In this mode there is probably no learning from experience, and whenever the unexpected occurs, one stops the unrelated analytical activity and focuses the entire mind upon the current situation. Second, masters of all skills experience moments of intense involvement during which the analytical mind is completely quiet. There is no awareness of the passage of time and only after these moments are passed is there awareness of what has taken place.⁸ This self-conscious concentration occurs during moments of masterful intellectual activity⁹ and moments of peak performance of highly trained motor skills. No mental energy is allocated to monitoring. It is during these episodes that action is faster than thought.

These bursts of masterful performance at speeds faster than thought are not achieved without risk. To concentrate all of one's resources on performance one has to relinquish



Courtesy of Grumman Aerospace Corp., Bethpage, NY

the monitoring function of the analytical mind, and thus run the risk of overlooking the true sense of the situation and blindly, albeit brilliantly, pursuing an inappropriate sequence of actions.¹⁰ In spite of the risk, pilots of the latest high-technology systems must be encouraged to cultivate this spontaneous mode of response. They must learn that in moments of crisis the analytical



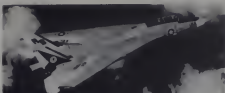
Courtesy of McDonnell Douglas

ceases to be appropriate needs improvement. Presumably, the intuitive mind, in moving from paradigm to paradigm, has gone down a path of association which has led to a current paradigm with an inappropriate associated action.

The intuitive mind is "locked into the wrong Gestalt." The job of the analytical mind is to get it out, and also to prevent this happening again.

Psychic, cont'd...

process that in general permits learning and avoids mistakes must be transcended. For the very highest performance, they must unlearn the learning habits which first made their acquisition of proficiency possible. □



Courtesy of Grumman Aerospace Corp.,

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Footnotes

† We have distinguished these stages in more detail and argued for their psychological reality in another paper.³

†† Psychologist Lee Brooks has experimentally shown that in certain situations subjects do, indeed, recognize patterns as similar to specific individual cases rather than as instances of a class defined in terms of necessary and sufficient features.⁵

††† This phenomenon, according to Colonel Evan J. Griffith, occurs during crucial moments of air-to-air combat.

†††† We do not mean, here, moments of creativity. We have no explanation of this ability to transcend all past experience.

††††† A pilot faced with a sudden emergency should first respond instinctively and virtually instantaneously, but if this burst of unmonitored activity fails to cope with the crisis the analytical mind must intervene to question the pilot's original intuitive sense of the situation. If by calling attention to overlooked aspects the analytical mind can summon up a more appropriate paradigm, action faster than thought may again be possible. But if no paradigm is found, the analytical mind must take over the production of performance and use whatever propositional knowledge is relevant. Two recent examples of last-recourse analytical brilliance by commercial pilots are: (1) Jack McMahan's use of the unusual downward pitch known to be produced by the rear engine of a Lockheed 1011 to compensate for a system failure leading to uncontrollable climb and (2) Harvey Gibson's use of the landing gear to slow the almost supersonic speed of a diving Boeing 727.⁹

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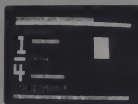
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ABF

Bob McCray

Lawyers, long symbolized by the quill and scroll, may soon be in for a new image if a new computer language recently introduced proves successful. And, if so, it could one day be that the computer may be as common in the law office as Black's Law Dictionary.

The computer language, called ABF (American Bar Foundation) was developed at the Vogelback Computer Center at Northwestern University in Evanston, Illinois, under the sponsorship of the American Bar Association. It was first introduced in February, 1978, at the American Bar Association Semiannual meeting.

Computers have, of course, been used for some time by law firms for a number of purposes, such as billing and legal research. However, the new language may allow the general lawyer to use the computer in his day-to-day practice.

Jim Sprowl, patent attorney and electrical engineer, who helped develop the system, explains that ABF may enable general lawyers to use legal computer programs that are set up by the legal specialist, allowing the lawyer to possibly handle more types and a higher volume of cases.

Sprowl, who teaches "Computers and the Law" at Northwestern University and IIT/Chicago-Kent Law schools, and has written the book, **A Manual For Computer-Assisted Legal Research**, recently published an article explaining the ABF language in the American Bar Foundation Research Journal, entitled "Automating The Legal Reasoning Process: A Computer That Uses Regulations and Statutes to Draft Legal Documents." Since October, 1978, the ABF Compu-



Law Professor Gary Laser (right), Director of the IIT/Chicago-Kent Law School Legal Services Center, assists a legal assistant with the ABF Computer law system as Jim Sprowl (standing, center) explains a legal document produced by the system.

ter Law System has been in operation on an experimental basis at the IIT/Chicago-Kent Law School Legal Services Center, using the full resources of a Control Data Computer under the direction of Law Professor Gary Laser.

The IIT/Chicago-Kent legal center is set up much along the lines of a teaching hospital in the medical field. Staffed by ten full-time practicing lawyer/professors, the center provides service, education and research. The computer/law project is part of the research function of the clinic. After an experimental period the center expects to fully incorporate the computer project into its education and service functions.

Presently, two ABF computer law systems are in operation. Both were



developed by clinical professors. An estate planning system processes 20 to 30 wills a month. With each case client information sheets are processed into the computer by a lawyer or trained intern, who executes commands, and receives a will as a print-out ready for editing.

A second computer law system in operation processes all the forms necessary for uncontested Guardianship (of the person) cases. Because of a need in the Chicago area, several public service organizations requested the clinic to devise an ef-

Lawyers, long symbolized by the quill and scroll, may soon be in for a new image.

ficient, low-cost system for handling a large volume of cases. Professor Laser anticipates processing up to 50 to 100 Guardianship cases in a single month.

Two other systems will soon be operating. A divorce system, being designed by Clinical Professor Carolyn Hughes, will involve interviews and interface with the computer at three stages during the legal proceedings — the complaint, trial and decree.

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Then to evaluate the experiment, Professor Ronald Staudt, Associate Director of the Legal Services Center, and a programmer at the Vogelback Computer Center in Evanston, are designing a time-accounting case management system. This should be in operation in a short time.

According to Professor Laser, it is too soon to predict how cost-efficient each of the systems will be. He says that the lawyers presently working with the system are enthusiastic about the possibilities, and view the computer as playing a role in the future, but in some instances believe the time investment required of the lawyer to learn the processor may be a drawback.

The new language may allow the general lawyer to use the computer in his day-to-day practice.

Ideally, however, Professor Laser maintains that when the ABF system is finally completed, a lawyer should be able to learn how to execute commands and work with the processor (where the computer delivery system is programmed already) in as little as two and one-half days. For the lawyers to learn how to program the documents onto the system would take significantly more training and continuous use.

Professor Laser feels that if the computer/law project experiment proves successful, both lawyers and clients could benefit. He adds that, although the present computer/law study has not been evaluated, he holds a personal opinion about computers formed from his experience in learning the power of the computer and from witnessing the rapid acceleration of new technology. In his personal opinion he estimates that within the next three or four years this kind of a system could dramatically lower the cost of legal services while at the same time improving quality. □



The Computer Store of the Month



Computer Corner of White Plains

In the late 60's and early 70's, a few forward-thinking people had the idea that public access to computers was a Good Idea. But computers were expensive and only a few of these projects got off the ground. Some notable ones were Bob Albrecht's People Computer Company in Menlo Park, CA; the Boston Children's Museum program run by Bill Mayhew and the Wang 2200B in White Plains Public Library. The moving spirits behind this last one were Hal and Harriet Shair. Hal was then employed at Consumer's Union. (See Creative Computing, Vol. 3 No. 3, pg. 36-38).

Then in 1976, Harriet Shair decided that it was time for a change from her teaching career. Altair and IMSAI had just announced their computers so it seemed like a ripe time to carry this public access idea one step further and open a small store in White Plains Mall.

The store has expanded four times since then and is the oldest continuously operating store in New York. Hal joined Harriet in the store in 1979.

In response to the growing needs of its community, the Computer Corner offers intensive seminars like "Basic Programming" in its seminar rooms. For small businessmen, a course in the business applications of the Apple computer is offered. The Computer Corner stocks vast amounts of software, books and magazines and supports the Apple, PET, North Star, Hewlett-Packard and Dynabyte. The store is a complete service center which sells components, interface boards, mainframes and comprehensive business systems.

The Computer Corner stocks Creative Computing Magazine, Press Books and Software. It is located in the White Plains Mall, 200 Hamilton Avenue, White Plains, New York 10601. Hours are Monday-Saturday 10-6; and Thursdays 10-9 PM. The telephone number is 914-WHY-DATA.

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A Consistently Well-Behaved Method of Interpolation

Russell W. Stineman

Were not an academic journal, but once in a while something serious and original comes in. This is apparently a real solution to a problem graphics guys know well; this paper gives a smooth slope-matching interpolating curve, without ever going wild.

Abstract

When a curve is represented in a digital computer by a table of points, many methods of interpolation have difficulty near an abrupt change in the slope of the original curve. The problem is evidenced by the interpolating curve having more inflection points than the actual function that it is intended to approximate.

Polynomial Interpolation often gives wild results near an abrupt change of slope.

This paper presents a method of interpolation which generates a curve that will never have more inflection points than are clearly required by the given set of points. The interpolating curve passes through the tabulated points and exactly matches the given slopes at those points (except for one unlikely degenerate case which has a slope discontinuity at one of the given points).

When used to approximate a sine function, the method of this paper was found to be more accurate than spline interpolation. The amount of computation required to find an interpolated point is approximately the same as to evaluate a sixth-degree polynomial.

An appendix presents a suggested way to compute slopes at the given points when only the points are known. However, exact slopes should be used whenever possible.

Introduction

In digital computer computations, it is common to represent a curve by a set of points, with interpolation between points. However, as is well

known, polynomial interpolation often gives wild results near an abrupt change of slope. Spline interpolation can also give unreasonable results.

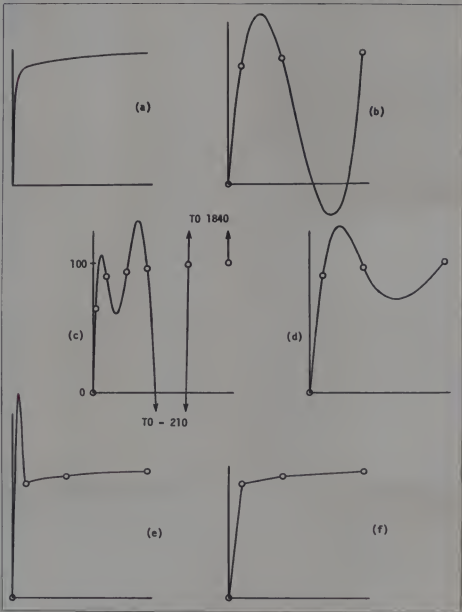


Figure 1

Russell W. Stineman, Boeing Aerospace Company, P. O. Box 3999, Seattle, WA 98124

The problem is illustrated in Figure 1. Curve (a) shows a monotonically increasing curve with an abrupt decrease in slope. In (b), four points on curve (a) have been fitted by a cubic polynomial, with completely unsatisfactory results. In (c), three additional points have been taken from (a) and all seven points have been fitted by a 6th-degree polynomial, still with unsatisfactory results. In (d), the same four points as in (b) have been fitted by three piecewise cubic polynomials, chosen to preserve continuity of first and second derivatives at the interior points ("spline" interpolation), again unsatisfactory. Piecewise cubics are also used in (e), but the slopes at the given points are made equal to the slopes in (a), also unsatisfactory. In desperation, many analysts have used linear interpolation as in (f), accepting the need for a relatively large number of points to achieve a given accuracy.

The complete assurance that the procedure will never generate "wild" points makes it attractive as a general-purpose procedure.

What is needed is an interpolation procedure with the following properties:

a. If values of the ordinates of the specified points change monotonically, and the slopes of the line segments joining the points change monotonically, then the interpolating curve and its slope will change monotonically.

b. If the slopes of the line segments joining the specified points change monotonically, then the slope of the interpolating curve will change monotonically.

c. Suppose that the conditions in (a) or (b) are satisfied by a set of points, but a small change in the ordinate or slope at one of the points will result in conditions (a) or (b) being no longer satisfied. Then making this small change in the ordinate or slope at a point will cause no more than a small change in the interpolating curve.

An interpolation procedure that has the above properties is given in the next section of this article. The last of the three properties is discussed later in the paper in terms of an example.

Interpolation Procedure

In the following discussion, it is assumed that $x_j, y_j, y'_j, j = 1, 2, \dots, n$ are given where

x_j, y_j = rectangular coordinates of j th point on curve.

y'_j = slope of the curve at j th point.

$x_j < x_{j+1}$ for $j = 1, 2, \dots, n-1$

If the slopes are not initially known, they may be calculated by the method described in the Appendix. Slopes thus calculated are consistent with achieving the objectives stated in the Introduction.

Given x such that $x_j \leq x \leq x_{j+1}$, the procedure for calculating y (the corresponding interpolated value) is the following. The slope of the line segment joining the two points is

$$s_j = \frac{y_{j+1} - y_j}{x_{j+1} - x_j} \quad (1)$$

Values of s_j may be precomputed and stored along with the given points and slopes. On the line segment, the ordinate corresponding to x is

$$y_0 = y_j + s_j (x - x_j) \quad (2)$$

Next,

$$\Delta y_j = y_j + y'_j (x - x_j) - y_0 \quad (3)$$

where Δy_j is the vertical distance from the point (x, y_0) to a line through (x_j, y_j) with slope y'_j , as shown in Figure 2. Similarly,

$$\Delta y_{j+1} = y_{j+1} + y'_{j+1} (x - x_{j+1}) - y_0 \quad (4)$$

Δy_j is the vertical distance from the point (x, y_0) to a line through (x_j, y_j) with slope y'_j , also shown in Figure 2. The product $\Delta y_j \Delta y_{j+1}$ is then calculated and tested.

If $y'_j = s_j$, then the line through point (x, y'_j) with slope y'_j will coincide with the line segment joining points (x_j, y_j) and (x_{j+1}, y_{j+1}) , and $\Delta y_j = 0$. Similarly, if $y'_{j+1} = s_j$, then $\Delta y_{j+1} = 0$. If either or both Δy_j and Δy_{j+1} are zero, then the product $\Delta y_j \Delta y_{j+1} = 0$, and y is simply

$$y = y_0 \quad (5)$$

If $\Delta y_j \Delta y_{j+1} \neq 0$, but Δy_j and Δy_{j+1}

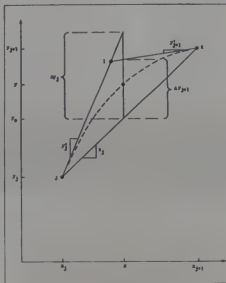


Figure 2

are not both zero, then the interpolating curve will have a slope discontinuity. For example, if $\Delta y_j \neq 0$, then the slope for $x_j < x < x_{j+1}$ will be $y'_j = s_j = y'_{j+1}$. But as $x \rightarrow x_j$ from the left, $y'_j \rightarrow y'_j \neq s_j$. This degenerate case is the only way a slope discontinuity can occur.

If $\Delta y_j \Delta y_{j+1} > 0$, then (as in Figure 2) Δy_j and Δy_{j+1} have the same sign, and

$$y = y_0 + \frac{\Delta y_j \Delta y_{j+1}}{\Delta y_j + \Delta y_{j+1}} \quad (6)$$

Equation (6) always determines the point (x, y) inside the triangle IJK of Figure 2. The slope of the interpolating curve matches the given slopes at the given points. The slope changes monotonically between the given points, so the interpolating curve is always concave toward the line segment joining the given points.

If $\Delta y_j \Delta y_{j+1} < 0$, then the geometry is like Figure 3, and there must be an inflection point between x_j and x_{j+1} . In this case,

$$y = y_0 + \frac{\Delta y_j \Delta y_{j+1} (x - x_j + x - x_{j+1})}{(\Delta y_j - \Delta y_{j+1}) (x_{j+1} - x_j)} \quad (7)$$

Equation (7) always determines the point (x, y) inside the quadrilateral JIKL of Figure 3, where the vertical distance LO equals the vertical distance OI. The slope of the interpolating curve matches the given slopes at the given points. The interpolating curve intersects line segment JK at its midpoint.

The rationale for equation (7) may be understood by considering the case where y_j is significantly greater than y_{j+1} , the slope of line segment JK, but y'_{j+1} is nearly equal to s_j , Figure 2 or 3. Regardless of whether y'_{j+1} is greater or less than s_j , points I and L will be very close to point J and the interpolating curve will be very close to line segment JK. Thus, a change of y'_{j+1} from slightly more than s_j to slightly less than s_j will cause only a slight change in the interpolating curve. This example illustrates the third requirement given in the Introduction.

Equations (6) and (7) fall in the general area of rational interpolation. However, the desirable properties of this method of interpolation stem from the particular form of (6) and (7). In general, rational interpolation does not have such properties.

The curve in Figure 1(a) was calculated by the above method of interpolation, given the four points shown in Figure 1(b), and with slopes calculated by the method given in the Appendix.

Accuracy

The accuracy of the given interpolation procedure may be illustrated

Interpolation, cont'd...

by fitting the function

$$y = \sin x \quad (8)$$

No attempt is made to get an optimum fit. Rather, the values chosen for x_i are 0, 45, and 90 degrees, and the corresponding values of y_i and y'_i are computed exactly using equation (8). The resulting interpolated curve deviates from $\sin x$ by a maximum of .00333, at $x = 24$ degrees.

By contrast, the maximum error using linear interpolation is .0704, at 68 degrees. From another standpoint, to achieve a maximum error of no more than .00333, linear interpolation requires that x be given at intervals of 9 degrees.

An example given in reference [1] considers one full cycle of the function given in equation (8). The points x_i are selected at 45-degree intervals (that is, $x_i = 0, 45, 90, \dots, 360$ degrees), and the values of y_i are calculated exactly by (8). Interpolation is then done with a fifth-degree spline. That is, piecewise fifth-degree polynomials are found such that the interpolating curve and its first four derivatives are continuous. The interpolating curve also exactly matches the first and third derivatives of equation (8) at $x = 0$ and at $x = 360$ degrees. The interpolating curve deviates from $\sin x$ by a maximum of .0372, at 25 and at 335 degrees.

The same 9 points as in the above example from reference (1) were fitted by the method of this paper, using slopes calculated by the method given in the Appendix, rather than exact slopes. In this case, the interpolating curve deviates from $\sin x$ by a maximum of .0766, at 18 and at 342 degrees. Using exact slopes, the maximum error is .00333, at 24, 156, 204, and 336 degrees. This shows the importance of using accurate slopes at the given

points, if the slopes are known.

Conclusions

A procedure has been presented for interpolating between tabulated points. This procedure completely avoids the problems which various forms of polynomial interpolation, including spline interpolation, have near an abrupt change of slope. The procedure is especially recommended for such applications as the voltage-current curve of a semiconductor. However, the complete assurance that the procedure will never generate "wild" points makes it attractive as a general-purpose procedure.

The procedure uses only ordinary arithmetic operations (that is, no

In desperation, many analysts have used linear interpolation, accepting the need for a relatively large number of points to achieve a given accuracy.

trigonometric, exponential, or similar functions need be evaluated. The number of operations is approximately equivalent to the evaluation of a sixth-degree polynomial. Memory required for data is four words per point.

When fitting a known function, the procedure given in this paper is at least as accurate as spline interpolation, provided that accurate values are available for the slopes of the function at the given points. For a given accuracy, the spacing of tabulated points may be significantly greater than for linear interpolation.

Appendix. Calculation of Slopes

Given the points $x_j, y_j, j = 1, 2, \dots, n$, the problem addressed in this Appendix is to compute slopes, y'_j , consistent with the requirements stated in the Introduction. It is assumed that the interpolating procedure given in this paper will be used.

In Figure 4, let I, J , and K be any three consecutive points. Point J may be above or below the line segment joining I and K , as shown in Figures 4(a) and 4(b), respectively. The requirements of the Introduction are satisfied if y'_j has a value between the slopes of the line segments IJ and JK . That is, for Figure 4(a), it is necessary that

$$\text{slope of } (IJ) > y'_j > \text{slope of } (JK) \quad (9a)$$

while for Figure 4(b),

$$\text{slope of } (IJ) < y'_j < \text{slope of } (JK) \quad (9b)$$

Another point is that if, for example, line segment IJ is much shorter than JK , it may easily be seen that a smoother overall interpolating curve will result if y'_j is nearly equal to the slope of IJ .

All of the above considerations are satisfied by setting y'_j equal to the slope at point J of a circle through points I, J , and K . Thus

$$y'_j = \frac{(y_j - y_i)((x_k - x_j)^2 + (y_k - y_j)^2) + (y_k - y_j)((x_j - x_i)^2 + (y_j - y_i)^2)}{(x_k - x_i)((x_k - x_j)^2 + (y_k - y_j)^2) + (x_j - x_i)((x_j - x_i)^2 + (y_j - y_i)^2)} \quad (10)$$

Equation (10) takes care of all interior points. The end points require special attention. From the requirements of the Introduction, it may be seen that the slope at an end point must have the same sign as the line segment from the end point to the next point. In line with the use of equation (10), one might try drawing a circle through the first (or last) three points. However, if either point I or K of Figure 4 is an end point, the particular arrangement of the points causes the slope of the circle at I or K to have the wrong sign. The sign of the slope is not necessarily wrong at the end point, but it may be wrong.

The problem divides into two cases. To simplify the notation, let M and subscript m designate either point I or point K , whichever is an end point, and let s be the slope of the line segment joining points J and M . The first case occurs when s is "steeper" than y'_j . In this case, a parabola through

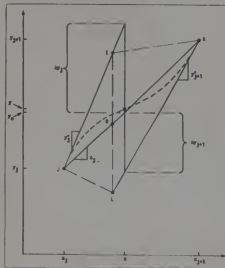


Figure 3

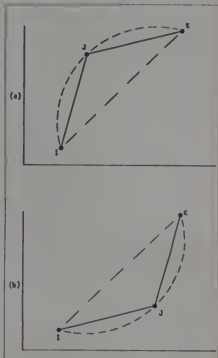


Figure 4

$$y_m^i = s + (s - y_i^h) = 2s - y_i^h \quad (11a)$$

The procedure uses only ordinary arithmetic operations. The number of operations is approximately equivalent to the evaluation of a sixth-degree polynomial. Memory required for data is four words per point.

$$y_m^1 = s + \frac{|s| (s - y_1^1)}{|s| + |s - y_1^1|} \quad (11b)$$

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A. C. Ahlin, *On Smooth Interpolation by Continuously Connected piecewise Polynomials*, Rendiconti del Circolo Matematico di Palermo, Serie II, Tomo XX, 1971, pp. 229-253.



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[illegible]

Fast Fourier Transform Fundamentals & Applications

Phillip L. Emerson, Ph.D.

The Fast Fourier transform can be used to understand much more than acoustical tones and carrier waves. The FFT allows you to study both periodic and aperiodic events of all kind.

If you have been intimidated by long, uninteresting assembly listings for the Fast Fourier Transform (FFT); if the FFT really is not very important to you; if you have only occasionally wished you had an FFT program; if the FFT will not substantially increase your income; if it is not one of your main goals in life; if your first reaction is "Why bother?" then this article is written for you. Read on. From the accompanying flow charts, even the most apathetic programmer will finish coding the FFT before running out of enthusiasm. Almost any computer will

What can you do with the FFT? You can get acquainted with it. You can demonstrate it to your friends and neighbors.

do, and any of the common languages can be used: Basic, Focal, APL, Fortran, assembly language, or whatever. It is easily done with standard hardware, but there are ample opportunities to exploit special gadgets such as PROM, floating-arithmetic modules, etc.

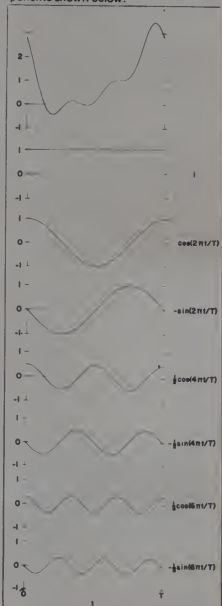
What can you do with the FFT? You can get acquainted with it. You can demonstrate it to your friends and neighbors. You can criticize it. You can try to beat it. You can monkey with it to make it run faster or occupy less

memory. It accepts an input sequence of samples of a signal, equally spaced in time (or some other dimension, if you have imagination), and performs a discrete Fourier transform on the sequence. For example, the output gives an estimate of how much each frequency component contributes, in a periodic signal, for the first $N/2$ harmonic frequencies, where N is the number of sample points in the sequence. Generally, the Fourier transform yields an analysis of a complex waveform into a set of simple additive sinusoidal components. The result, in one of several possible equivalent forms, is frequently referred to as the "spectrum" or "spectral representation" of the waveform. Such an analysis is pictured in Figure 1, for a signal of length T . The complex waveform at the top consists of the additive superposition of the seven simple waveforms below. The numerical representation of the analysis dispenses with the graphical illustrations of the waveforms and presents only the "spectrum" of coefficients of the cosine and sine-wave components at the different frequencies. Table 1 shows this form of the analysis of the complex waveform at the top of Figure 1. The contribution of the steady component, a_0 , is usually called the "DC" component due to the influence of electrical engineers on the terminology. The coefficients, a_1 and b_1 , indicate the contributions of the cosine and sine components of period T (in seconds). These components are of frequency $1/T$ which is called the fundamental frequency or first harmonic. The coefficients, a_2 and b_2 , indicate the contributions of the cosine and sine components of period $T/2$, or at twice the fundamental frequency (second harmonic), while a_3 and b_3 specify the contributions of the components of period $T/3$, at a frequency



Figure 1.

The complex wave at the top is analyzable into the seven simple sinusoidal components shown below.



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Transform, cont'd...

	j			
	0	1	2	3
a _j	1	1	1/2	1/3
b _j		-1	-1/2	-1/3

Table 1

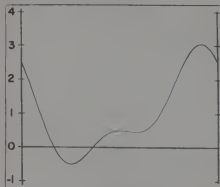
Coefficients of the cosine and sine components of the wave form at the top of Figure 1.

of three times that of the fundamental (the third harmonic). The cosine and sine waves at a given frequency have exactly the same waveform, but one is shifted a quarter of a wavelength in phase relative to the other. The weighted sum of the cosine and sine waves at a given frequency is itself a simple sinusoidal wave of the same form and frequency, but with a phase shift determined by the relative weighting, and with an amplitude equal to the square root of the sum of the squares of the two weights. Although applications of the Fourier transform are not restricted to periodic signals, the terms "frequency," "harmonic," etc., have become standard because many of the early applications were to periodic phenomena in acoustics.

Fourier analysis is still frequently applied to periodic signals such as an acoustical tone, or a carrier wave from a radio transmitter. There are several reasons for doing so, one of the most important being that the nonlinearities of a network can be revealed. The output of a linear network contains only the frequency components that are present in its input. Therefore, the presence of new frequency components in the output indicates a non-linearity, and the pattern of such new frequency components is sometimes

Figure 2

A filtered version of the wave shown at the top of Fig. 1. This wave is reconstructed from only the first five of the seven components of Fig. 1.



used to characterize the nonlinearity. Aside from analyzing signals to see the contributions of the various frequency components, perhaps before and after the action of an amplifier, it is possible to use the Fourier transform to predict the effects of various kinds of filters on a signal. In fact, it is common to think of filtering in terms of its selective action at various regions along the frequency scale. A lowpass filter attenuates the components at high frequencies, leaving those at lower frequencies relatively unaffected. A simple illustration of this principle is shown in Figure 2, where the complex waveform at the top of Figure 1 has been reconstructed, but with the modification of setting $a_3 = 0$ and $b_3 = 0$. Attenuation of high-frequency components has a "smoothing" effect on the signal.

It is possible to use the Fourier transform to predict the effects of various kinds of filters on a signal.

For many years, the standard tool in the analysis of speech and other animal sounds, has been an expensive piece of special-purpose hardware that, essentially, performs Fourier transforms on a large number of successive short samples of the sound to be analyzed. Interest in speech analysis has accelerated recently because the market is ready for automatic speech recognition and synthesizing systems (see Robinson, 1979a, 1979b). Also, voice-print systems operate on data in a similar form. Digital numerical techniques for rapid performance of Fourier transforms (i.e., the FFT) have only been in existence for a few years, but in some cases they are replacing the more traditional and highly expensive sound spectrographic hardware. It is now possible for computer hobbyists to dabble with speech analysis and synthesis using only a general purpose digital computer and, perhaps, A-to-D and D-to-A converters. A more general application of the Fourier transform is in the search for periodic components in a signal contaminated by random noise. Ocean tides, sunspots cycles, stock-market fluctuations and various biological phenomena have been analyzed in this way. A noisy signal is transformed, and the spectrum is inspected for any peaks that project above a general amplitude level attributable to the noise. If any peaks are found, an extrapolation equation can be constructed, including only these dominant periodic components, to

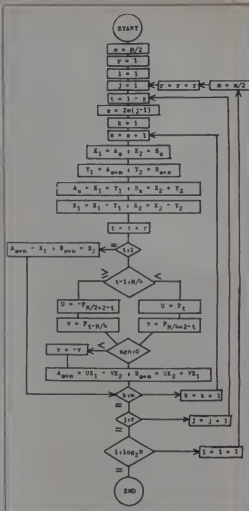


Figure 3

Fast Fourier transform: the frequency-decimation method with radix 2. This method requires postshuffling which can be done by subsequent execution of the routine of Fig. 4. The variables U and V are the elements of the X , Y , A , B , and P arrays are real variables. All other variables and constants are integers.

predict future events with better-than-chance accuracy. The currently popular pseudoscience known as "biorhythm" purports to make predictions of a person's future state of being, on the basis of presumed periodicities in the fluctuations of psychophysiological variables. The implausible part of the theory is that the frequencies of the periodic components are assumed *a priori*, that they all are assumed to begin at a certain phase point at birth, and that they are supposed to remain perfectly locked to the initial phase throughout life. Though there is little doubt that there are important psychobiological rhythms, it is clear that their phases are frequently modified in haphazard

ways by environmental events (e.g., pregnancy and the menstrual cycle). Also, it is known that the periods of some of the cycles vary, on the average, from individual to individual. What is needed to make biorhythm serious is the application of the Fourier transform to recent sequences of measurements on the person whose future state is in question. As with tides, sunspots, etc., the significant periodic components would be

What is needed to make biorhythm serious is the application of the Fourier transform to recent sequences of measurements on the person whose future state is in question.

identified approximately as to frequency, amplitude, and phase, and useful short-range forecasts could be made. Other uses of the FFT, and there are some, are beyond the scope of this article. Papers in the volume edited by Liu (1975) discuss a number of uses and also the logic of the FFT. Blackman & Tukey (1958) have treated many of the questions that arise in the spectral analysis of discrete sequences of measurements of noisy signals.

The FFT is a certain computational procedure, developed only a few years ago, for performing a Fourier transform on a signal given as a discrete series of numerical measurements, equally spaced. It reduces the number of arithmetical operations from about N^2 , for more direct methods, to about $(N \log_2 N)/2$, where N is the number of sample points in the series to be transformed. The time savings are substantial when N is large. The gain in speed is due to some efficiencies that are made possible by performing the calculations in a certain sequence that appears rather complicated, especially if one is trying to modify or translate an existing computer program to a different programming language. The apparent complexity is greatly reduced, here, by the use of a well-known programming crutch, the flow chart. A flow chart concentrates on the logic of the algorithm, purposely ignoring the idiosyncrasies of the target programming language. The flow chart is general; it can easily be translated into any common programming language. Moreover, the logical structure of a process is much more apparent from a flow chart than from

a list of commands. The conventions used in the flow charts presented here are standard. Nonconditional arithmetical operations are enclosed in rectangular boxes. Conditional branches are indicated by diamond shaped boxes, with labels on the outward branches. Lines connect boxes to indicate the flow of control. Generally, the flow is from the top, downward. When the flow is not downward, the direction is indicated by an arrowhead. Labels on outward branches from decision boxes may be omitted when redundant, e.g., if one outward branch is labeled, and there is just one other one, unlabeled, it should be interpreted as the condition complementary to that of the labeled one.

Two algorithms are presented in the flowcharts in Figures 3 and 4, to be used as subroutines that are called by some main program that must minimally handle the input and output to peripheral devices, and define certain parameters. The preparations that must be made before starting to make transformations are as follows. The number of elements, N , in the sequence to be transformed, must be defined as some positive integral power of 2. If the number of points in an actual data sequence to be transformed is not an integral power of 2, a string of zeros should be appended to it to satisfy this requirement. Next, a quarter-wave cosine table must be constructed or read in. In the flow charts, the values are referred to as P_k , $k = 1, 2, \dots, N/4 + 1$. They are defined as $P_k = \cos(2\pi(k-1)/N)$. The FFT can be performed in the

The market is ready for automatic speech recognition and synthesizing systems.

forward (time-to-frequency) or backward (frequency-to-time) direction, with reversal of the algebraic sign of one variable. This sign is taken care of in the flow charts by the variable, sgn , which should be given the value of -1 for a forward transformation, or $+1$ for a backward one. There are two N -element arrays operated upon by both subroutines. These are referred to in the flow charts as A_k and B_k , $k = 1, 2, \dots, N$. These arrays should contain the input sequence to be transformed when the FFT is begun, and they will contain the transform when the FFT is finished. The input sequence is not preserved. A pair of elements, (A_k, B_k) , implicitly represents a complex number, although the

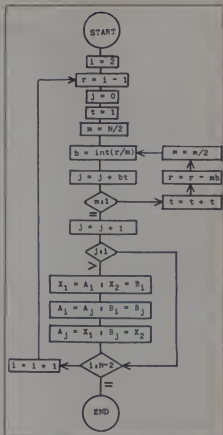


Figure 4.

Shuffle routine for the FFT: binary-address bit reversal. The X , A , and B array elements are real; all other variables and constants are integers.

arithmetic operations specified in the flow charts can be programmed as real and integer arithmetic. If your software supports complex arithmetic, you may define a single complex array in place of the A and B arrays. The input data ordinarily will be a time sequence of real numbers. When that is the case, they should be loaded into the A array, and all elements of the B array should be set to zero.

After the main program has defined N , constructed the cosine table in the P array, defined the value of sgn to be -1 or $+1$, and loaded the data into the A and B arrays, the routines of Figures 3 and 4 should be executed in that order. The first one performs the main computations of the FFT, but leaves the transform in a certain scrambled order. The second routine sorts the frequency components into their natural order. Some of the boxes in the flow charts contain pairs of real operations, separated by semicolons. Each of these pairs corresponds to a complex arithmetical operation, and could be coded as a single complex statement. For software not supporting complex arithmetic, each member

Transform, cont'd...

Table 2
Fast Fourier Transform of a square wave
with N = 8.

k	A _k	B _k
1	4.000	0.000
2	1.000	-2.414
3	0.000	0.000
4	1.000	-0.414
5	0.000	0.000
6	1.000	0.414
7	0.000	0.000
8	1.000	2.414

of a pair requires a separate real arithmetic statement. The symbol, $\text{int}(r/m)$, in Figure 4, means to take the integer part of r/m .

After execution of the routines of Figures 3 and 4, the FFT is complete, but often one wants to identify the results in terms of the notation used earlier to refer to the contributions of the cosine and sine components of the transform, as indicated by the lower-case coefficients, $a_0, a_1, b_1, a_2, \dots$ etc. These are obtainable from the A_k and B_k arrays after the FFT, as

$$a_0 = A_0/N$$

$$a_j = (A_{j+1} + A_{N-j+1})/N$$

$$b_j = (-B_{j+1} + B_{N-j+1})/N$$

for $j = 1, 2, \dots, N/2$. One can then compute the power at frequency j/T , where T is the duration of the N samples, as $a_j^2 + b_j^2$. The amplitude is the square root of the power.

But before starting to transform actual data, compute power or amplitude spectra, etc., perhaps one should test the program on something simpler. Let $N = 8$, and set the first four elements of the A array to 1, the last four to zero, set all elements of the B array to zero. This is a square wave of period 8. Table 2 shows the result of transforming it to three decimal places. Here are some other tests that can be tried with various values of N . Remember that it is necessary to recompute the elements of the P array when the value of N is changed. Set $A_k = \cos(2\pi(k-1)/N)$ and $B_k = 0$, for $k = 1, 2, \dots, N$, and perform the transformation. The result should be $A_k = N/2$, $A_0 = N/2$, and zeros everywhere else. Next, set $A_k = \sin(2\pi(k-1)/N)$ and $B_k = 0$, for $k = 1, 2, \dots, N$, and perform the transformation. You should find $B_k = N/2$, $B_0 = N/2$, and zeros elsewhere. Set $A_k = 1$ and $B_k = 0$, for $k = 1, 2, \dots, N$. This is DC signal, and the result of transforming it should be $A_0 = N$, and zeros elsewhere. If these tests are successful, within rounding or truncation error, there is another one that is more general, but equally easy to make. The FFT is reversible with the following adjustments. After the transformation from any input sequence to the frequency representation, (1) set $\text{sgn} = +1$ and (2) divide each element of the A and B arrays by N . Then execute the routines of Figures 3 and 4 again. This should restore the original time sequence.

Don't forget to set $\text{sgn} = -1$ again before starting another transformation in the forward direction. In any case, after a forward transformation, one should find $B_0 = 0$, and because N is necessarily an even number, $B_{N/2+1} = 0$.

There is no reason why one should not try out the FFT in an interpretive language such as Basic, and perhaps even make some serious use of it for

The logical structure of a process is much more apparent from a flow chart than from a list of commands.

small N . It will execute slowly, however, perhaps taking a second or two even for $N = 8$. For ambitious number crunching with large N , one should plan on converting to a compiler language such as Fortran, or to assembly language. The fastest versions are written in assembly language using integer arithmetic entirely, with periodic rescaling of the numbers to avoid overflow and minimize underflow. Reports of 1.5 seconds for $N = 2048$, and 8 seconds for $N = 8192$, are typical.

In addition to the flow charts for the two subroutines, a complete Basic program is included. This program has been tested in SOL Basic/5, and it consists of the two subroutines of

```

10 REM FROM HERE TO AOB IS A MAIN
70 REM PROGRAM TO READ N, READ DATA, PERFORM
30 REM FFT, PRINT RESULTS, THEN READ ANOTHER
40 REM SET OF DATA, ETC.
50 REM BASIC/5 HAS BEEN TESTED WITH SOL
60 REM BASIC/5 ON A PROCESSOR TECHNOLOGY
70 REM SOLS SYSTEM WITH 16 K OF
80 REM MEMORY.
90 REM
100 DIM A(64),P(64),C(17)
110 PRINT "TYPE N, AN INTEGRAL POWER OF 2, UP TO 64."
120 INPUT N
130 M=N
140 L=N
145 L=L+1
150 M=M+8
160 IF M=N THEN GOTO 1A5
170 REM L WILL BE LOG2(M)
180 T1=241.141527
185 S1=1
190 FOR I=1 TO M/4
200 P(I)=COS(T1*(I-1)/N)
210 NEXT I
220 PRINT "TYPE IN DATA"
230 FOR I=1 TO M
240 INPUT A(I)
250 B(I)=0
260 NEXT I
270 GOSUB 1200
280 GOSUB 1500
290 PRINT "THE FOURIER TRANSFORM"
300 PRINT "I A(I) B(I)"
310 FOR I=1 TO M
320 PRINT I A(I) B(I)
330 PRINT
340 GOTO 220
345 REM
350 REM PROGRAM VARIABLES ARE MOSTLY
360 REM SAME AS THOSE IN FIGS 3 AND 4
370 REM DECEPTIONS ARE:
380 REM P=FLOW CHART PROGRAM
390 REM BLOWLOW CASE)
400 REM C=
410 REM LOG2(M)
420 END
430 REM
440 REM

```

```

1200 REM SUBROUTINE FOR MAIN PART
1210 REM OF FFT ALGORITHM
1220 REM (FLOW CHART, FIG. 3)
1230 M=M/2
1240 R=1
1250 FOR I=1 TO L
1260 FOR J=1 TO R
1270 T1=R
1280 S2=M*(J-1)
1290 FOR K=1 TO M
1300 S1=A(S2)
1310 Y1=A(S2+M)
1320 Z1=S1+Y1
1330 X1=S1-Y1
1340 A(S2)=X1+Y1
1350 B(S2)=Z1+Y1
1360 X1=X1-T1
1370 Y1=Y1-T1
1380 IF T1=1 THEN GOTO 1300
1390 A(S2)=X1
1400 B(S2)=Y1
1410 IF T1=1 THEN GOTO 1300
1420 U=P(I)
1430 V=P(I)
1440 W=U+V
1450 X=U-V
1460 Y=X+V
1470 Z=X-V
1480 NEXT J
1490 NEXT I
1500 REM
1510 REM SUBROUTINE FOR SHUFFLE ROUTINE
1520 REM (FLOW CHART, FIG. 4)
1530 FOR I=2 TO M-2
1540 M2=I+M/2
1550 J=I
1560 T1=
1570 M2=M/2
1580 O=INT(M2/N)

```

```

1590 J=J+M2
1600 IF M2 THEN GOTO 1650
1610 T1=T1+1
1620 M2=M2+1
1630 M2=M2
1640 GOTO 1580
1650 J=J+1
1660 IF J=M2 THEN GOTO 1700
1670 X1=A(J)
1680 Y1=B(J)
1690 Z1=X1+Y1
1700 X1=X1-Y1
1710 RETURN
1720 END

REM
TYPE N, AN INTEGRAL POWER OF 2, UP TO 64.
TYPE IN DATA

1
A(I) B(I)
0 0
2 0
3 0
4 0
5 0
6 0
7 0
8 0

```

Transform, cont'd...

Figures 3 and 4, with a main program that reads in data to be transformed, defines the parameters, as described above, calls the two subroutines, and puts out the results. In SOL Basic/5, the INPUT command is a request by the program for input directly from the terminal keyboard, rather than from data statements. The PRINT command, in SOL Basic/5, puts information out to the terminal video display. Otherwise, SOL Basic/5 seems to conform to many other versions. The LET command identifier is optional and has been omitted throughout the program. The maximum value of N for the program listed here is 64. This can be changed simply by changing the dimension statement. □

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It is no news that people who program computers make many decisions affecting our lives. They have a hand in determining when our bills are due, and mail us letters on every conceivable subject. Now their passion for uniformity is changing the way many of our names are spelled. They are unfamiliar with the admonition attributed to Harry Truman, "I don't care what they say about me, just so long as they spell my name right." If Harry were around today he would find they might talk about him *and* misspell his name.

While I attempt to hang onto this most obvious evidence of my ancestry, I am being deprived of it. It is becoming homogenized into something no longer distinctive, no longer my name.

In my own case, I am happy with my Irish name. The coat-of-arms with background information that I ordered by mail said our clan motto is "Vulneratus Non Victus," Wounded Not Broken. The motto is prophetic, because the name is being wounded and perhaps broken; so are the names of countless others.

While I attempt to hang onto this most obvious evidence of my ancestry,

I am being deprived of it. It is being changed without my assent. It is becoming homogenized into something no longer distinctive, no longer my name.

It isn't the O that is dropped, (though sometimes it is moved around); it's the apostrophe. It is disappearing. The apostrophe is being removed by people who set up credit card bills. Department stores feel the same way. So do magazine subscription houses, banks, insurance companies, the government; in fact just about everybody who uses a computer to prepare and print bills or envelopes for large mailings.

The results are interesting, if you don't care how your name is spelled. In my case the most common variation is made by moving the O over as an extra middle initial and I become JOHN J O GRADY. You would think people performing this surgery would feel just a touch of conscience. Not at all. The alterations they perform where they make mailings for the "Whale Report" are major. They cut out the apostrophe, transform two letters and it comes out regularly as OGRULY. Then, to add insult to injury, they furnish their mailing list to others who compound the thing.

Capital letters help blur origins, too, because those of us whose names begin with an O or a La or De continue the spelling by using another capital letter. When you blend it all together you remove the distinction and it could be a name from any European country. (That well-advertised credit card company might be contributing to the identity crisis.)

If I'm complaining, I wonder how

the famous surgeon DeBakey feels about DEBAKEY. The DeCets are probably beginning to accept DECET and the deChadenes are surely fighting an up-hill battle. So are the LaRosas. The Al-Rashids have become ALRASHID!

You would think people performing this surgery would feel just a touch of conscience. Not at all.

A glance through the phone book indicates that some, weary of the fight, follow the course of least resistance and adopt technology's way. It is not unusual to find Oroureke, Oneill, Odonnell, Deluna, Lasasso in telephone listings.

It is a shame for us to submit to name changes when "word processors" haven't thought to include upper and lower case letters on their printing machines or because an apostrophe has been left off the keyboard. All of this in the interest of efficiency and expediency to save one character or a blip on a magnetic tape.

Usually when one requests a correction be made they are met with absolute indifference. "Our computer can't handle that." So, our names bend to accommodate the machinery.

There remains one more weapon for use in my personal battle. It will strike in an area where the blip and character counters can least afford to lose. I can increase the count in my name by three characters by adopting the Gaelic spelling O'Gradaigh. □

John J. O'Grady, 10540 W. 62nd Ave., Arvada, CO 80004

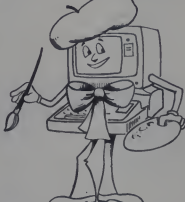
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"Dungeons & Dragons" is the most popular of the new breed of "role-playing games" coming on the market. Although it is intended as a pencil and paper game, several versions exist for home computers. There is a fair amount of bookkeeping involved in the game, so if you have a computer you will probably want to make use of it. If you don't already have a computer, perhaps this is just the excuse you've been looking for to buy one. Before we show how a computer can be used, though, let's learn something about the way the game is played.

What Is Dungeons And Dragons?

The basic idea behind Dungeons and Dragons (D&D) is really quite simple. One person is called the Dungeon Master, or DM, and acts as the game moderator. He creates the dungeon by drawing a map of each level of the dungeon. Each map is keyed showing locations of monsters, traps, treasures and other special features. The DM then writes a complete description of the appearance and features of each room or encounter area in the dungeon. The word "dungeon" is used in a generic sense as the actual adventure may take place in any kind of environment — a haunted house, a wilderness, a city, or maybe even a real dungeon.

Each of the other players creates one or more characters which may be fighters, magic users, clerics, or thieves. They may be human, elf, dwarf, halfling, or half-orc. Dice are rolled to determine the characters' Strength, Intelligence, Wisdom, Dexterity, Constitution, Charisma, Wealth and Hit Points (a measure of life force). The players then spend some of their wealth on equipment they wish to take on the adventure.

Finally, all is ready and the expedition enters the dungeon. The game then assumes a dialogue format, with the DM describing what the characters see or what happened to them, and the spokesman for the players telling the DM what the characters are doing. Perhaps an example will make this clearer. This expedition has already been exploring the dungeon for some time:

DM: "You are at an intersection of two corridors, one running north-south and the other east-west."

Player: "We look north."

DM: "The corridor extends as far as you can see (30 feet). There is a door in the West wall 20 feet down the corridor."

Put a Dungeon In Your Computer

Glen Charnock



Player: "We approach the door and the thief listens at it."

DM: "The door is a stout oaken door and nothing is heard from beyond."

Player: "We try to open the door."

DM: "It's locked."

Player: "The thief tries to pick the lock."

DM: "It was a simple lock and he succeeds."

Player: "We open the door and the two fighters step in, ready for battle."

If you don't already have a computer, perhaps this is just the excuse you've been looking for to buy one.

DM: "You see a room, 30 by 40 feet in size. The door you just entered was in the middle of the 30 foot wall. This room appears to be some sort of burial vault. There are at least a dozen coffins resting on low pedestals spaced throughout the room. Four of the coffins' lids are rising. Skeletons are emerging from them, and a voice seems to come from nowhere booming, 'Who dares disturb the tomb of Kings?' The skeletons have picked up swords and are advancing on the party in a menacing manner."

In the above example, the characters were searching for the crown of the Wolf King which would enable its wearer to control wild wolves that were

threatening the characters' village. The goal of an expedition may vary. In this case the characters had to find a specific object. Sometimes the goal is merely to enter the dungeon, find a lot of treasure, and get out alive. Still other games may require that a certain act be performed in some set period of time. The rules are completely flexible and individual creativity is strongly encouraged.

The official rules are published by TSR Hobbies, Inc., PO Box 756, Lake Geneva, WI 53147. You will probably want to start by getting their "Basic Set" which contains a 48-page instruction manual (large pages!) and a prepared dungeon module complete with maps, descriptions, etc. Later, as your interest and funds dictate, you may want to get their other rule books, including the most recent books on "Advanced Dungeons & Dragons." Most game stores carry these and related items, so check your yellow pages under "games." Many game stores also have table space available for players to meet and play D&D or other games, so finding gaming partners shouldn't be a problem.

The above description and example give you the idea of how the game is played. If it sounds good to you so far, by all means get the instructions at your local game store. You will need them, as they contain lists of costs of equipment, tables of monsters and their characteristics, magic spells that your magicians and clerics may use, and details of combat procedures — who gets hit by whom and how much damage is done — and much more.

There are two ways in which a computer can be used. The computer can be programmed to act as a DM so that you play "against" the computer, or you can create one or more programs which will allow the computer to assist the DM or the players (or both) but where a human DM will still be required.

If you decide to let the computer be the DM your job is both simpler and harder. It is harder because the program will be longer and much more complex, but it can also be simpler because there are several such programs already for sale. Jade Computer Products sells "Super Dungeon" for the Apple and "Adventure" is available from national distributors (including *Creative Computing*) for the TRS-80, CP/M, Apple, or PET. If you don't want to buy the game you still have some help in writing one in the form of Scott Adams' detailed article in the August 1979 issue of *Creative Computing*.

A computer DM is an excellent way to introduce someone to this type of role playing game. In fact, my first experience was with a form of Adventure on a DEC 2020 system at the National Computer Conference. It can also be a fun way to pass some time even if you normally play with a live DM. Unfortunately, the computer DM is always limited no matter how complex the program. (This is more a practical than a theoretical limitation — an unlimited computer DM would require too much memory and would be too slow on a hobby computer). Since one of the most important parts of D&D is that it encourages individual creativity, I feel that a computer DM will always lack an essential element of the game. I enjoy playing against a computer, but if given a choice, I'll take a live DM every time. Let's take an example. You have written code in your computer DM to allow for players encountering a door. They may listen at it and test to see if it is locked. If unlocked they may open it, and if locked they may try to pick the lock or break it down by force. Your new player has gotten locked in the room. He doesn't want to make much noise lest he attract the enemy guards, and he was unsuccessful at picking the lock. Did you allow for him removing the hinges and sliding the door out of its frame? You didn't? Gee, that's too bad, you just stifled his creativity. This situation actually arose in a live game. (The hero got away safely — that time.) Murphy's law applies strongly to computer DMs. No matter how many alternatives you have allowed for, your players will always find one which you didn't and will usually find it the first time they enter your dungeon.

If you do decide to write your own computer DM, at least be sure it is nice and flexible like Scott Adams' so you can fix these little problems as you find them.

A Computer DM

Writing a computer DM program is similar in many ways to writing an interpreter. You, the player, give some command to the program, it is acted upon, and the result is returned to you. The key to success is to have a well designed data base consisting of information about the dungeon, its geography, and contents. See the Scott Adams article mentioned earlier for a good example.

The data base must contain all the information needed for any command that the player may give. Therefore, before you can set up a data base you must know what commands are to be allowed. From that you can determine what information must be kept in your data base. Let's look at some common commands and see what sort of things a computer DM may be able to handle.

Super Dungeon (mentioned earlier) begins with only the commands WALK, RUN, OPEN DOOR, CLOSE DOOR and HELP. Most of these are obvious. HELP prints the list of usable commands which may be augmented as the player gains experience or acquires new devices.

Some other commands you may want to allow in your DM are: MOVE, CLIMB, GO UP, GO DOWN, LOOK, EXAMINE, SEARCH, LISTEN, OPEN (jar, bottle, chest, door, or whatever), CLOSE (same list), PICK A LOCK, CAST A SPELL, FIGHT, HIT, THROW, EAT, DRINK, TASTE, SIP, TAKE, PICK UP, GRAB, STEAL, SAY, SPEAK, TOUCH, FEEL, POKE, TEST, SHOVE, DISPLAY, MAP, READ, PUT ON (ring, cloak, etc.).

Again, most of these are obvious. LOOK gives a description of the room or hallway you are in, while EXAMINE gives a detailed description of an object such as a book, table, etc. SEARCH will find hidden items in the area searched. LISTENing at closed doors is frequently a good idea before you barge in! (Just watch out for one problem — in one game a player listened at a door soon after entering the dungeon and heard heavy breathing sounds and a heartbeat, "Lub dub, lub dub, ..." He didn't want to find out what that was! For the next half hour, every door he listened to hid a similar creature. Always the same heavy breathing and heartbeat. Finally, he couldn't stand the suspense and opened one of the doors. There was nothing there! Just an empty room. Eventually he realized that when listening he hadn't taken off his helmet and each time he had heard his own breathing and heartbeat!)

TASTE and SIP allow a player to sample an edible item without actually ingesting a full dose. This way you may find out if food is poisoned, or you may get a hint of the effects of some magic potion you have found without having the full effect hit you. POKE, TEST, or

There are at least a dozen coffins resting on low pedestals spaced throughout the room. Four of the coffins' lids are rising.

FEEL may be defined to allow cautious players to test something without actually touching it themselves. Poking something with the far end of a 10 foot pole before going closer has saved many lives. SHOW, DISPLAY and MAP may be used to inquire into the computer's data base. You may, for example, want to show what items are in a character's possession, or review the dungeon map if your program generates one for you. Many magic items are made in the form of jewelry or garments. PUT ON allows you to acquire their magic abilities (assuming you have such an item to put on). Likewise TAKE OFF allows the removal of the item.

If all of this sounds complicated, there is a good reason. It is. A computer DM can be as complicated as you care to make it. When built on a good data base and using modular coding techniques, the result can be a powerful program that is still easy to understand and modify.

When writing your computer DM, start with a small set of commands and add more as you find you need them. In this way you can debug as you go and your program will grow along with your experience.

The Computer As A Support Tool

Even if you don't want to write a computer DM program, there are a number of ways in which your computer can help you play or DM. The first program you will probably want as a player is a good character generator. See the accompanying listing. This program allows you to choose whether you want to create a fighter, magic user, cleric, or thief and whether he should be human, elf, dwarf, halfling, or half-orc. If necessary, it should be a straightforward job to add new classes or races by following the pattern of the existing code. Once you have chosen a class and race, the program generates random numbers for the basic attributes (Strength, Intelligence, Wisdom, Dexterity, Con-

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Dungeon, cont'd...

stition and Charisma). Next, these scores are modified according to the character's race. Dwarves, for example, are sturdier but less likeable than humans so their constitution is increased one but their charisma score is lowered one point. There are also minima and maxima for each attribute which varies according to the race and the scores are adjusted to comply with these restrictions. Likewise, there are limits based on the character's class so the scores are adjusted again to comply with these limits. The character's wealth and hit points are based on his class so these random numbers are generated next. (Hit Points, sometimes referred to as Hits To Kill, are a measure of how much damage a character can sustain before dying.)

At this point, the basic data about the character is printed. The character's attributes determine his abilities. For example, a player with a high charisma of 18 could hire up to 15 henchmen while a player with only a charisma of 3 could hire but 1 henchman. These details are printed next. Due to lack of memory on the computer I was using, I have included only the strength and intelligence modules but it should be obvious on examining them how to add modules for the other abilities. Simply insert the GOSUBs after line 1330 and the modules themselves starting at 4600. In a similar manner, data related to the character's race and class are printed next. Finally, the program loops to allow you to generate more characters.

Once you have your character generator program running, you may want to write a combat program. The computer, having been fed data about the combatants (names, hit points, armor, weapons, etc.) can conduct the battle and print a detailed description of who was hit by whom, where, how much damage, etc. A good human DM can do this also, but usually the attempt bogs down in looking up tables to see whether a hit was in the hand, foot, body, etc. and how much damage the limb in question was able to survive. The computer is much faster and can maintain all these tables in its memory and so produce lively combat.

You may want the computer to help with your bookkeeping tasks. It can keep track of the time spent and advise when rest or food is needed. It can tell when a torch is burnt out or how much oil you have left, who is carrying which treasure, etc. Many times this bookwork is left undone because it slows down the game. Since the computer can do it easily and quickly, detailed accounting becomes

feasible and adds a new dimension of reality to the game.

A more ambitious project might be to allow the computer to map the dungeon as the players explore it. Players would enter the dimensions given by the DM relating to what they see, and the computer would use its graphic display to provide the map. One thing that will cause a problem with players or computers creating maps is a teleportation device. Your character steps through an ordinary looking door and vanishes. He has been teleported to some other area of the dungeon. He may or may not realize that he has been moved. Eventually the map will begin showing inconsistencies and the player may suspect something funny has happened but even so, may not know just

No matter how many alternatives you have allowed for, your players will always find one which you didn't and will usually find it the first time they enter your dungeon.

where or what it was. Your program must somehow allow for these situations to be resolved and any incorrect segments of the map to be corrected. You may even want to implement a "save" command that you may give to instruct the program to save the current state of the map on disk so that it can be retrieved later to aid in correcting such situations. More than one map should be "saveable" so that there can be several generations of backup maps. If you do get lost, the DM should not help you find yourself again. You must retrace your steps as best as you are able in order to find out where you went wrong. This is just what you would have to do if you were there in person.

No matter what sort of programs you want to use to assist you, always consider whether you might someday want to include that routine in a computer DM program, then plan ahead to minimize conversion efforts if you do decide to use it later. If you aren't sure how to do this, look for articles or books on "Modular" design and on "structured programming." These techniques will help in any programming you do, whether it's today's game or tomorrow's payroll. Good luck and happy dungeoning. □

It would be a swell world if everybody was as pleasant as the fellow who's trying to skin you.

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The original computer version of **Adventure** was written by Willie Crowther and Don Woods in Fortran on a PDP-10 at MIT. In this version the player starts near a small wellhouse. Upon entering the house, he finds food, water, a set of keys and a lamp. Armed with only these items, he must set out to explore the countryside in search of treasure and other objects of play. He must also confront dwarfs, snakes, trolls, bears, dragons, birds, and other creatures during his quest. The game accepts one- or two-word commands such as GET LAMP, SOUTH, or KILL DWARF. Of course, if you don't have the proper tool to carry out an action, or if you do something foolish, you may find yourself in big trouble.

In playing the game you wander thru various 'rooms' (locations), manipulating the objects there to try to find 'treasures'. You may have to defeat an exotic wild animal to get one treasure, or figure out how to get another treasure out of a quicksand bog. You communicate thru two-word commands such as 'go west', 'climb tree', 'throw axe', 'look around'.



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 1720 GOTO 620
 2000 REM *** EDIT HUMAN SCORE: ***
 2010 REM "HUMAN"
 2020 GOTO 930
 2030 REM
 2040 REM
 2050 REM *** EDIT AND ADJUST ILVIN SCORE: ***
 2060 REM
 2070 REM
 2080 REM
 2090 REM
 2100 REM
 2110 REM
 2120 REM
 2130 A6 = "ELVIN"
 2140 A(1) = A(0)+1
 2150 IF A(1) THEN A(1)+3
 2160 IF A(1) THEN A(1)+3
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 2230 REM *** EDIT AND ADJUST DMARVIN CHARACTERISTICS ***
 2240 REM
 2250 REM
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 2280 REM
 2290 REM
 2300 REM *** EDIT AND ADJUST DMARVIN CHARACTERISTICS ***
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CIRCLE 112 ON READER SERVICE CARD



The Dakin's 12-in-1 Utility Kit gives your programming more punch!

Dakin's Corporation, a Colorado software house, is making available to the public 12 utility programs on one 5 1/4 sector diskette, utilizing the new Apple DOS 3.3, which provides 231 more storage.

All of the Dakin's Programming Aids 3.3 programs are also compatible with the Corvus Disk Drive system.

Features

- Remove REM statements and comment code to increase program speed and save memory and disk space.
- Copy any file or program from one diskette to another. Only the name is needed.
- Print or display a line cross reference and variable name cross reference.
- Print or display all or selected records from a text file.
- Display any sector of a given file or program, and then update any data within that sector, or specify the sector you wish to update, such as directory sectors and sectors occupied by DOS.
- Create, print and modify your own text and Exec files.
- Copy a diskette without DOS; in Apple is a registered trademark of Apple Computer Inc.

The Controller is a registered trademark of Dakin's Corporation

CIRCLE 120 ON READER SERVICE CARD

tialize without DOS; verify source diskette; verify copied data is the same as the original.

- Use a powerful data entry routine that handles both string and numeric data.

Plus Many More Utility Programs for Sophisticated Programmers

Many of these utility programs have been developed and tested for in-house use while producing The Controller™ business package for Apple Computer Inc.

Suggested retail price for Dakin's Programming Aids 3.3 is \$70.00.

Each programming aids package includes a program diskette and very complete documentation, all attractively packaged in a padded, blue print vinyl 3-hole notebook with silver lettering. An identifying tab separates each program for convenient reference.

See your Apple dealer or contact Dakin's Corporation, P. O. Box 21187, Denver, Colorado 80221. Telephone: (303) 426-6090.

DAKIN'S
CORPORATION

APPLE PASCAL

If you have it, you'll want this program. If you don't, here is a great reason to get it.

INFOTREE

The Personal Information Manager

Infotree is a Hierarchic Information Management System designed for personal use. It allows you to easily store, retrieve, alter and organize information any way you want. A wide variety of commands allow you to update and query the database that you designed! Listing or printing of individual items or entire "subtrees" requires but a single command. Cross Referencing across data structures is easy. It even prints mailing labels. Low Level I/O and block buffering makes Infotree blindingly fast! Human Engineering makes it brilliantly simple! Single keys select commands and retrieve previously entered keys. Applications include mailing lists, directories, memos, scheduling, anything you can think of. This system, providing far more than anything comparable on the market today, costs only \$69.95.

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CIRCLE 148 ON READER SERVICE CARD

P&T CP/M® 2 & TRS-80 MOD II versatility!

P&T CP/M 2 is customized to take maximum advantage of the Mod II hardware and still be compatible with standard CP/M

So What? There are hundreds of applications programs available (from dozens of sources) to run under CP/M and most of them can run unmodified on the Mod II with P&T CP/M 2

So Why P&T CP/M 2? When you compare CP/M's for the Mod II you will find that P&T CP/M 2 is way out in front of the pack. We were the first to offer **596K bytes** (1610,304 bytes) of storage at double density. We have the **most advanced screen driver** with features like cursor addressing, insert/delete line, optional non-scrolling lines, change cursor size and blink, clear to end of line or screen, read cursor position, read character at cursor, and more. We also support a **time of day clock**, a user supplied real time interrupt routine, and the **Line Printer III**. Our serial port drivers support, ETX/ACK, XON/XOFF, and status line (CTS and DCD) handshaking.

Ok - What about documentation? We supply the / standard Digital Research manuals for CP/M plus our own 150 page manual describing in detail how to use P&T CP/M 2

What's all this cost? ONLY \$75!
(\$185 after Aug. 11)



Product: (C) Marketline (C) Siro-tech, Inc. All rights reserved.

Shipping extra. Call for shipping and handling charges.

PICKLES & TROUT

P.O. BOX 1206, COLETA, CA 93017, (805) 967-9563

CP/M is a trademark of Digital Research Inc.

TRS-80 is a trademark of Tandy Corp.

CIRCLE 179 ON READER SERVICE CARD

ACTION, STRATEGY, AND FANTASY for the SERIOUS games player

Brain Games - 1 demands ingenuity.

Two players bombard radioactive material with protons and electrons until it reaches critical mass and sets up a Nuclear Reaction. *Dodgem* requires you to outmaneuver another player to get your pieces across the board first. *Dueling Digits* and *Parrot* challenges your ability to replicate number and letter sequences. *Tones* lets you make music with your Apple (16K) CS-4004 \$7.95. *Strategy Games* and *Brain Games* are on one disk (16K) CS-4503 \$14.95.

Strategy Games - 1 keeps games players in suspense.

You and your opponent trail around the screen at a quickening pace attempting to trap each other in your *Blockade*. A 7 category quiz game will certify you as a *Genius* (or an errant knave!). Beginners will meet their master in *Checkers*. *Skunk* and *UFO* complete this classic collection (16K) CS-4003 \$7.95.

Know Yourself through these valid self-tests.

Find out how your life style effects your *Life Expectancy* or explore the effects of *Alcohol* on your behavior. *Sex Role* helps you to examine your behavior and attitudes in light of society's concept of sex roles. *Psychotherapy* compares your feelings, actions, and phobias to the population's norms and *Computer Literacy* tests your microcomputer savvy. A fun and instructional package (16K) CS-4301 \$7.95. *Know Yourself* and *CAI Programs* are on one disk (16K) CS-4503 for \$14.95.

IMAGINE



THINK



You're in command in Space Games - 1.

Maneuver the TIE fighters into your blaster sights and zap them with your lasers to save the rebel base camp from annihilation in *Star Wars*. *Rocket Pilot* is an advanced real time take off and landing game. High resolution graphics, exploding saucers and sound effects add to the suspense as you repel the *Saucer Invasion*. Finally, a bonus graphics demonstration, *Dynamic Bouncer* (16K) CS-4001 \$7.95. *Space Games* and *Sports Games* are on one disk (16K) CS-4501 for \$14.95.

ACTION

Sports Games - 1 puts you in the Apple World Series

Take the field in the *Great American Computer Game*. Mix up your pitches to keep the batter off balance. Move your fielders to snag the ball before he gets to first. *Balls and Strikes*, double plays, force outs, and errors let you play with a realistic strategy. Also in the line up—*Slalom*, a championship downhill ski race, *Torpedo Alley*, and *Darts* (16K) CS-4002 \$7.95. *Space Games* and *Sports Games* are on one disk (16K) CS-4501 for \$14.95.

It's easy to order SENSATIONAL SOFTWARE for your Apple II.

Send payment plus \$1.00 shipping and handling in the U.S. (\$2.00 foreign) to Creative Computing Software, P.O. Box 789-M, Morristown, NJ 07960. NJ

Residents add \$1.00 sales tax. Visa, MasterCard and American Express orders may be called in toll free to 800-631-8112 (In NJ 201-540-0445).

For a FREE Sensational Software Catalog of over 400 programs for eight popular systems circle reader service #300.

PASSAGE (753), NEW CONSTRUCT (UN753), SILLUINE OR SHIFTING WALLS (565 2/33), PIT TROPS, FALING BUILT TROPS, AND OTHER STOVE WALLS (1505), AND THEY MAY VETERINE THEIR DEPT'S UNDERGROUND! SO! OF THE TIME REGARDLESS OF 1 IN LOCATION

THEY HAVE 4.1 TO HIT AGAIN HALL-ORCS, GOBLINS, HOBGOBLINS OR OTHER. WHEN MARVES ARE ATTACKED BY OCH'S, TROLLS, GIANTS, OR MONSTER-LIKE MONSTERS, SUBTRACT 4 FROM THE OPPONENT'S HIT ROLL BECAUSE OF THE UNARY SILENT STONES OR ARROWS.

WARRIORS CAN USE ANY MOVING STONES OR ARROWS, POTIONS, 17TPPS

1-6
THIS PROGRAM GENERATES CHARACTERS FOR TSR'S GAME OF
THUNDERIONS AND DRAGONS. YOU MAY GENERATE CHARACTERS OF ANY
MIXED COMBINATION OF CLASS AND RACE FROM THE FOLLOWING TABLE:
CLASS 1 FIGHTER RACE 1 HUMAN

CLASS 2 MAGIC USER
CLASS 3 CLERIC
CLASS 4 THIEF

RACE 2 ELF
RACE 3 DWARF
RACE 4 HALFLING
RACE 5 HALF-ORC
RACE 6 HALF-ELF
RACE 7 GNOME
RACE 8 GOLEM
RACE 9 HUMAN
RACE 10 MONK
RACE 11 NINJA
RACE 12 SAMURAI
RACE 13 TROLL
RACE 14 VAMPIRE
RACE 15 WIZARD

ENTERING A 0-0 TERMINATES THE PROGRAM.
ENTERING -1-1 CAUSES THE INSTRUCTIONS TO REPEAT
WHEN REQUESTED. ENTER THE CLASS NUMBER, A COMMA,
AND THE RACE NUMBER THAT YOU DESIRE.

GOOD LUCK ON YOUR ROI!
ENTER CLASS, RACE NUMBERS: 2, 3
MAGIC USERS MUST BE HUMAN OR ELFIN
CLERICS MUST BE HUMAN OR HALFDRACS
PLEASE TRY AGAIN
ENTER CLASS, RACE NUMBERS: 3, 5

	HALF-ORC	ADOLTE.	(CLERIC)	NAME *	SEX *
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STRENGTH	16	INFLUENCE	13
WISDOM	13	DEXTERITY	10
CHARISMA	18	CHARISMA	12

	WEIGHT ALLOWANCE +3
WHIT PROBABILITY NORMAL	DAMAGE ADJUSTMENT +1
OPEN DROPS IN 1 3/4	BEND PAGES/LIFT GRATES 10X
HEALTH = 90 (3P)	

THE CHARACTER MAY LEARN 3 ADDITIONAL LANGUAGES
HALF OR 3 SPEAK ORC/34, THEIR ALIGNMENT TONGUE, THE COMMON
TONGUE, AND MAY LEARN A MAXIMUM OF 2 OTHER LANGUAGES.

THEY HAVE INTRAVENOUS AND CAN GET 60° NINE DARTS.

THE CLERIC IS DEDICATED TO ONE OR MORE DILETTES AND HAS SOME SKILL BUT HOWEVER THEY MAY NOT USE EDGE OR POINED WEAPONS.

CLERICS MAY TURN AROUND THE LINEAR INCLUDING CHASTS, CHOSTS, CHAULS, LICH'S, HUMPH'S, SLA TMS, KELETONS, SPECTRI 3, WIGHTS, WRAITHS, VAMPIRES, AND ZOMBIES.

CLERICS MAY USE MOST POTIONS AND RINGS, ALL CLERICAL SCROLLS, AND MANY OTHER MAGIC ITEMS INCLUDING ARMOR AND WEAPONS.

CLERICS CAN BE POISONED, HEAVY'S.

ENTER CLASS, RACE NUMBERS 3-4
IMPLICIT USERS MUST BE HUMAN OR ELAUN
CLIENTS MUST BE HUMAN OR WALE-ORCS
PLEASE TRY AGAIN
ENTER CLASS, RACE NUMBERS 0-0
STORY IN LINE 7-10
READY

HALL-GRAD	AQUA-VITE (CLINIC)	NAME	SEX
ALIMENT * ETIOLOGH	17	INTELLIGENCE	15
WISDOM	14	DEXTERITY	11
CONSTITUTION	16	CHARISMA	12
HITS TO KILL	9		(7, 10, 8)

HIT PROBABILITY +1. DAMAGE ADJUSTMENT +1. WEIGHT ALLOWANCE +500.
OPEN BARRS: ON 1-3/4. BEND BARRS/LIFT GRATING: 13%
THE CHARACTER MAY LIE IN 4 ADDITIONAL LANGUAGES
HAI ORCH, SPEAK ORCHISH, THEIR ALIGNMENT TONGUE, THE COMMON
TONGUE, AND MAY LEARN A MAXIMUM OF 2 OTHER LANGUAGES.

THE CLERIC IS DEDICATED TO ONE OR MORE DIETRIES AND HAS SOME SPECIALTY WORK. HOWEVER, THEY MAY USE LIGHT (40 POINTS) WEAPONS. CLERICS MAY JOIN ANY OF THE UNITS INCLUDING CHAS'NS, G.O.S.'s, BACULUS, LILLAG, PUMMELS, SWANONS, SKILLTONS, SPELTRES, NIGHTS, WEAVERS, WIND'CS, AND ZORIN'S.

CLERICS MAY USE MOST POTIONS AND KINGS; ALL CLERICAL SCROLLS; AND MANY OF THEIR MAGIC ITEMS INCLUDING MAGIC ARMOR AND WEAPONS. LICH'N, OF LOUGHS, ENGL'N OR FOINTN' WEAPONS.

44-11

HAIRLING ROGUE (THIEF)	NAME	INTELLIGENCE	DEXTERITY	CHARISMA	SEX
ALIGNMENT *		14	16	17	
STRENGTH		16	17		
WISDOM		12			
CONSTITUTION					

HITS TO KILL	(.6)
HEALTH	* 80 (P)
HIT PROBABILITY	NORMAL
DAMAGE ADJUSTMENT	NONE
WEIGHT ALLOWANCE	+200

THE CHARACTER MAY BE IN 3-4 DIFFERENT LANGUAGES, INCLUDING SOME THAT INVOLVE ELFIN, Gnome, GOBLIN, HALFLING, DWARF, THEIR ALLIES, AND ENEMIES. THE CHARACTER CAN SEE UP TO 100 FEET IN THE DARK. THE WALK PLAINS WITH PURE STAGNANT BLOOD TO HAVE A 60" INFANTISATION RANGE.

THEY HAVE A 75% CHANCE OF DETECTING A SLOPING PASSAGE, AND CAN ALWAYS FIND THE SOURCE OF ANY SUCH PASSAGE. THEY MAY BE 'NEUTRAL' IN THE MEANS THEY USE TO OBTAIN THEIR GOALS.

THEY MAY BE VERY HARMFUL, GOBLIN, THEY MAY BE HARMFUL OR CHAOTIC. THE VERY HARMFUL YET CHAOTIC OR STEAL THYR PERSUASIVE BUT THEY MAY BE LEATHER ARMOR AND CAN USE MANY WEAPONS. THEY MAY BE LIKELY TO STAY CLOSE, IN THE DARK THEY CAN ENGAGE IN FIGHTING.

ENTER CLASS, RATE NUM RS 1,3
JULIEN VETERAN (FIGHTER) NAME

ALIGNMENT =	16	INTELLIGENCE	12
STRENGTH <td>16 <td></td> <td></td> </td>	16 <td></td> <td></td>		
WISDOM <td>18 <td></td> <td></td> </td>	18 <td></td> <td></td>		
DEXTERITY <td>16 <td></td> <td></td> </td>	16 <td></td> <td></td>		
CONSTITUTION <td>24 <td>CHARISMA</td> <td>13</td> </td>	24 <td>CHARISMA</td> <td>13</td>	CHARISMA	13
HITS TO KILL	6 <td>(D 10)</td> <td></td>	(D 10)	
CR			
MP			
PROBABILITY NORMAL			
IN 3-3/6			
LOOKS IN			
WEIGHT ALLOWANCE			
1-10%			

THE CHA-INTER MAY LIE IN 3 A. NATURAL LANGUAGES BECAUSE OF THEIR INFLUENCE ON THE CHA-INTER. THE CHA-INTER MAY LIE IN 3 A. NATURAL LANGUAGES BECAUSE OF THEIR INFLUENCE ON THE CHA-INTER. THE CHA-INTER MAY LIE IN 3 A. NATURAL LANGUAGES BECAUSE OF THEIR INFLUENCE ON THE CHA-INTER.

In early 1977 a friend gave me a printout of the USS Enterprise that fascinated me so much that I spent 90 hours putting it on our computer. Since I work for the 400th Aerospace Applications Group, Offutt AFB, Nebraska, I had little trouble in finding people who wanted copies.

When Star Wars first appeared at movie theaters, I dropped the idea of reproducing other Star Trek prints and began plans for several scenes from the Star Wars movie. As the job became easier, I also began work on Battlestar Galactica pictures. The biggest one, of the Battlestar Galactica, took over 170 hours of total time to create. Requests for prints came from everywhere.

Eventually, I produced 40 pictures of different subjects, some in 8 lines/inch format for high detail and others at 6 lines/inch. I have found my prints appearing in homes where each symbol was painted in fluorescent paint and in schools where children glued dyed rice to them to make a mosaic. They have even been scheduled for the summer arts festivals here in Omaha, and around the state.

Shaun P. Egan, 7411 So. 72 Ave., La Vista, NE 68126

DRAGON

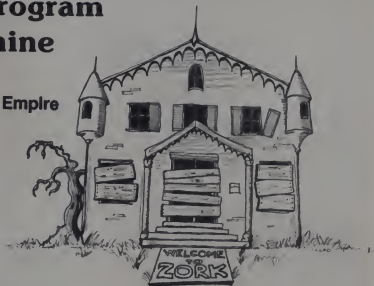
Shaun P. Egan

How to Fit a Large Program Into a Small Machine

or

How to fit the Great Underground Empire
on your desk-top

Marc S. Blank
and
S. W. Galley



As a rule, "sophisticated" programming is pretty boring — optimizing the unnecessary to speed up the uninteresting. Here, however, is an incredibly sophisticated package intended for fun and games. The more you know about software, the more astounded you will become as you read this.

Imagine yourself sitting down at your favorite personal computer, inserting a diskette, turning on the power, and seeing what follows. Your typed replies are in capital letters.

Zork: The Great Underground Empire
part 1, release 1

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West of House

You are standing in an open field west of a white house, with a boarded front door.

A rubber mat saying 'Welcome to Zork!' lies by the door.

There is a small mailbox here.

>OPEN THE SMALL MAILBOX

Opening the mailbox reveals a leaflet.

>READ THE LEAFLET

(Taken)

Marc S. Blank, 2315 Stearns Hill Rd. Waltham, MA 02154, and S. W. Galley, 285 Gray St., Arlington, MA 02174.

Welcome to Zork: The Great Underground Empire

Zork: The Great Underground Empire is a game of adventure, danger, and low cunning. In it you will explore some of the most amazing territory ever seen by mortals.

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Z-code strings work out to about five and a half bits per visible character, which is still significantly more compact than eight bits.

The original ZORK was created by Tim Anderson, Marc Blank, Bruce Daniels, and Dave Lebling. It was inspired by the ADVENTURE game of Crowther and Woods. This version was created by Marc Blank, Dave Lebling, Joel Berez, and Scott Cutler.
>WALK AROUND THE HOUSE
North of House

You are facing the north side of a white house. There is no door here, and all the windows are boarded up. To the north a narrow path winds through the trees.

>AGAIN

Behind House

You are behind the white house. A path leads into the forest to the east. In one corner of the house there is a small

window which is slightly ajar.

>LOOK IN THE WINDOW

You can see what appears to be a kitchen.

>GO IN

The kitchen window is closed.

>OPEN IT

With great effort, you open the window far enough to allow entry.

>GO IN

Kitchen

You are in the kitchen of the white house. A table seems to have been used recently for the preparation of food. A passage leads to the west and a dark staircase can be seen leading upward. A dark chimney leads down and to the east is a small window which is open.

On the table is an elongated brown sack, smelling of hot peppers. A bottle is sitting on the table.

A quantity of water

>PICK UP

pick up what?

>ALL BUT THE SACK

kitchen table: An interesting idea . . . glass bottle: Taken.

quantity of water: I can't reach that.

>GO WEST

Living Room

You are in the living room. There is a door to the east, a wooden door with strange gothic lettering to the west, which appears to be nailed shut, and a large oriental rug in the center of the room.

There is a trophy case here. A battery-powered brass lantern is on

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You may access any external data file, with either fixed length or sequential records. The MAGIC WAND converts the record into variables that you define and can use like any other variable. Of course, you may use the data for automatic form letter generation. But you can also use it for report generation.

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How to, cont'd...

the trophy case. Above the trophy case hangs an elvish sword of great antiquity.

This transcript shows the beginning of an adventure into a land of Zork. Zork was originally a single "computerized fantasy simulation" game in which the object is to explore a labyrinth, called the Great Underground Empire, comprising a variety of interesting caves or rooms, and to find hidden treasures and return safely with them. We now say that Zork is a computer-game environment in which different games, with different scenarios and different puzzles to solve, can be written. A Zork player converses with a Zork program by typing commands in a kind of restricted English and reading the program's English responses. A longer description of the original game and program can be found in "Zork: A Computerized Fantasy Simulation Game" by Lebling, Blank, and Anderson (IEEE Computer, April 1979, pp. 51-59).



Status bits represent qualities of a Thing, both permanent (edible, burnable, fightable, "room," etc.) and temporary ("lit," "open," etc.).

The original Zork game was implemented on a DECsystem-10 at the MIT Laboratory for Computer Science in a local Lisp-like language called MDL. This Zork game was later translated into a Fortran version for DEC PDP-11 computers and made available through the DECUS program library. In both versions the program is large: it occupies most of a process's virtual storage on a 10, and it requires a large disk for secondary storage on an 11. In converting Zork to run on personal computers, the designers needed some way to shrink it in order to fit it into the relatively small available storage.

One shrinking tactic was to remove the features of MDL that are not needed in Zork, such as coroutines, associative storage, and fancy input/output. The stripped-down version of MDL that resulted was named Zork Implementation Language (ZIL). However, that was not enough: a straightforward compilation of a ZIL version of the original Zork game into the machine language of any known personal computer would still have

produced an executable program too large to fit.

The solution was to invent a "virtual machine," specifically designed to execute Zork programs; the virtual "Z-machine" has a machine language called "Z-code," in which Zork programs can be expressed very compactly. Then all that was needed was a Zork Interpretive Program (ZIP), written in the machine language of any given target personal computer, that would imitate a Z-machine in carrying out the Z-code operations. (A compiler that translates from ZIL to Z-code is also needed, of course, but the highly-structured nature of MDL, and hence ZIL, makes that a relatively simple task.) A good benchmark for the storage saved by rewriting Zork in ZIL is the Zork parser, which analyzes a player's English input: the parser for the PDP-10 occupies 10K 36-bit words, while the Z-code parser, which is actually better functionally, occupies only 9K 8-bit bytes.

This Z-code approach is similar to that of compiling a Pascal program into "P-code," (although there are now P-code machines, like Western Digital's Pascal Microengine™, that are real and not just virtual). In effect, Z-code is like P-code: a string of subprogram calls, with the bodies of the subprograms executed by a Z-machine or ZIP. Any often-used sequence of operations in Zork programs could, in

principle, be compressed into a Z-code instruction, thereby moving the sequence of operations into the Z-machine or ZIP, where it needs to appear only once. The Z-machine designer just has to be judicious in choosing Z-code bit patterns and subprogram parametrizations to get the most benefit from this virtual-machine method.

Besides compressing the space needed by Zork programs, the Z-code approach also makes conversion to another (real) computer easier, because, assuming that the design of Z-code is reasonably machine-independent, all one needs to do is to implement ZIP on the new machine.

Z-code objects:

Z-code is an object-oriented language (as are Lisp and MDL and ZIL). In this section the various kinds of objects and the possible operations on them are described. Excerpts from a transcript of a game are used to illustrate the uses of these objects.

All Z-code objects occupy one or two bytes in storage, and exactly two bytes while they are being processed. Like MDL, ZIL uses "type codes" to distinguish among the different types of objects, but Z-code does not, to save space; the ZIL compiler checks for proper use of types, but ZIP doesn't bother. A Z-code operation that yields a truth-value (integer 0 or 1) is called

(as in Lisp) a "predicate"; the Z-code operation-codes for all predicates include a bit for inverting the sense of the test, another space-saving measure.

Dam Lobby

This room appears to have been the waiting room for groups touring the dam. There are exits here to the north and east marked "Private," though the doors are open, and an exit to the south.

Some guidebooks entitled "Floor Control Dam #3" are on the reception desk. There is a matchbook whose cover says "Visit Beautiful FCD#3" here.

>COUNT MATCHES

You have 5 matches.

>COUNT NOSES

I don't know the word 'noses.'

Integer:

An Integer, such as the number of matches left in a matchbook, is stored in two bytes, according to the normal bit-level representation used by the hardware. Operations on Integers include the four normal arithmetic functions, remainder or modular reduction, and generation of a random integer in the range 1-N. (Modular reduction — calculating the remainder in a division — is useful for stepping through a set of English responses cyclically. Random-integer generation is useful for choosing a response at random from a set of similar responses.) Predicates test for one integer being less than, greater than, or equal to another Integer, and for an integer being zero. (Since the sense of a test can be reversed using one of the bits in its operation code, this means implicitly that there are also predicates to test for greater-than-or-equal, less-than-or-equal, not-equal, and not-zero.) Testing for zero may seem redundant, given an equality test, but it is used often enough that the cost of using another operation code is outweighed by the value of eliminating the byte that would be used to hold a zero in every instance. Naturally, there is an operation to "print" an Integer in the output stream — though, of course most personal computers display characters on a CRT rather than printing them on paper.

In some situations an Integer is treated as a string of 16 independent bits; for this case there are operations for Boolean "and" and "or" and "not," and for testing individual bits. The characters in the player's input are also stored as Integers, using the ASCII code; for this case there is an output operation to print a single character, as shown in the last response above.

The Troll Room

This is a small room with passages to the east and south and a forbidding hole leading west. Bloodstains and deep scratches (perhaps made by an axe) mar the walls.

A nasty-looking troll, brandishing a bloody axe, blocks all passages out of the room.

Your sword has begun to glow very brightly.

>KILL TROLL WITH KNIFE

The blow lands, making a shallow gash in the troll's arm! The troll swings his axe, and it nicks your arm as you dodge.

>AGAIN

The quickness of your thrust knocks the troll back, stunned. The troll slowly regains his feet.

>AGAIN

A quick stroke, but the troll is on guard. The troll swings his axe, but it misses.

>AGAIN

A good slash, but it misses the troll by a miller. The axe crashes against the rock, throwing sparks!

>AGAIN

The troll is alarmed by a subtle feint past his guard. The troll, now worried about this encounter, recovers his bloody axe.

The name of a Thing identifies it uniquely to the player throughout the whole game, e.g., "Kitchen," "bottle," "thief."

String:

As you can see, Zork programs tend to be wordy, so strings of characters need to be stored as compactly as possible. Three characters can fit in two bytes, if each character uses only five bits. But five bits can encode only 32 characters directly, and that is obviously not enough. The solution is to use different "contexts" and to reserve one or more "characters" for switching among contexts. (This technique is similar to the five-bit Baudot code, which was used by early Teletypes before ASCII was invented.) Z-code strings use three contexts — lower case, upper case, and digits/punctuation — and several characters for switching among the contexts, either "permanently" or only for the next character, the latter in order to capitalize a word or use a single punctuation mark. Because of the extra characters used to switch contexts, Z-code strings work out to about five and a half bits per visible character, which is still

significantly more compact than eight bits.

The only operation on strings is to print them, i.e., show them to the player. There is no need to manipulate them, except to print strings sequentially so that they form sentences for the player. (Actually, simply because it occurs so often, there is also an operation for printing a string and then returning from a function call.) Most strings are stored without "new-line" characters, and ZIP takes care of "folding" the output into lines of a size convenient for the particular display being used; a few rigidly-formatted strings do use new-lines in order to draw a crude picture with the characters.

>SWIM

I don't really see how.

>SWIM

I think that swimming is best performed in water.

>SWIM

Perhaps it is your head that is swimming.

...

>TAKE HOUSE

What a concept!

>AGAIN

A valiant attempt.

>AGAIN

You can't be serious.

>AGAIN

Not bloody likely.

>AGAIN

An interesting idea...

Table:

A table is used to keep a set of related objects (like the responses above) together, as a list is used in Lisp or a record is used in Pascal. A table is stored as a number of two-byte (or sometimes one-byte) objects one after another. The length of a table is sometimes stored in its first element — to be used by parts of a program that need to step through all the elements — and sometimes not — if the program itself knows how long the table is. Operations on a table can get a word (two bytes) out of it and put a word into it; get a single byte out and put one in; and move the pointer along to another element (like CDR in Lisp) or backwards to a previous one (like BACK in MDL). (Actually, since a pointer to a table is just a plain address, ordinary addition and subtraction are used to move a pointer forward and backward in a table.)

Thing:

"Things" are probably the most interesting objects, since they represent the player, rooms, enemies, weapons, treasures and so on — the stuff of which a game is made. To avoid confusion, "Thing" will always be

How to, cont'd...

A Thing's contents part relates it spatially to other Things in three ways: as a parent ("container") as a child ("containee"), and as a sibling ("in-mate"). For example, if the knife and the bottle are in the kitchen, then the kitchen's "child" slot would hold the number of the knife, the knife's "sibling" slot would hold the number of the bottle, and the knife's (and bottle's) "parent" slot would hold the number of the kitchen. (Of course, depending on how they got there, the knife and the bottle might be interchanged in this data structure.) Such a data structure is commonly called a list: Things can be added to or removed from a list simply by moving the appropriate numbers into the slots. Manipulating list structures of this kind — the reason Lark was invented — is essential in Zork games, as Things get moved here and there by the player. For convenience, "contents" has a more general meaning in ZIL: for example, the player's baggage is "contained in" the player Thing. The operations on contents are

- "move X into Y,"
- "remove X from everything" (e.g., if it is eaten or otherwise destroyed),
- "is X in Y?" and "what is X in (if anything)?" (using X's parent slot),
- "what is the first Thing (if any) in X?" (using X's child slot), and
- "what is the next Thing (if any) in the same Thing that X is in?" (using X's sibling slot).

Program pages are kept on disk until needed and then read in to a suitable page frame for interpretation.

This is the attic. The only exit is a stairway leading down. On a table is a nasty-looking knife. A large coil of rope is lying in the corner.

>TAKE NASTY KNIFE
Taken.

...

Maze
This is part of a maze of twisty little passages, all alike.

A skeleton, probably the remains of a luckless adventurer, lies here. Beside the skeleton is a rusty knife.

The deceased adventurer's useless lantern is here. There is a skeleton key here. An old leather bag, bulging with coins, is here.

>TAKE RUSTY KNIFE

As you pick up the rusty knife, your sword gives a single pulse of blinding blue light.



Finally, each Thing has a table (in the format described previously) of its properties, such as name, size, capacity, score value, verbose description, north neighbor, synonyms, and action routines; the last can be seen in the transcript above involving the two knives. (The name of a Thing identifies it uniquely to the player throughout the whole game, e.g., "kitchen," "bottle," "thief." There is a special Z-code operation for printing a Thing's name.) Since there are a limited number of properties a Thing can have, and not all of them require the same amount of storage, a special format is used to store them in this table: the first byte of each property has a five-bit property number (allowing 32 different properties) and a three-bit count of the number of immediately following bytes used to store the property. The operations on properties are "get property Y of Thing X," "store Z as property Y of Thing X," "get the storage address of property Y of Thing X," and "get the next property of Thing X following this property."

>SCORE

Your score would be 10 (total of 375 points), in 9 moves. This score gives you the rank of Beginner.

Variable:

Variables are used to keep track of the situation all through the game. (Parts of Things are used also.) For example, the player's current score is a variable, called a "global" variable because it is the same no matter what functions have been called. Like Things, variables are identified by a

one-byte number. A special number is used to identify the top of the "stack," and fifteen more numbers identify "local" variables used by the function currently executing. (The stack is described later.) The remaining 240 numbers identify global variables. Operations on variables store and retrieve the current value, increment or decrement an integer value by one and optionally test it for crossing a given threshold, push a value onto the stack, pop a value off the stack, and print the value.

Other operations:

The remaining Z-code operations do not deal directly with objects. These operations include the null operation, go-to (jump, branch), call a function, return a value to the calling function, and return "true" or "false" or whatever is on top of the stack to the calling function. Also there are special operations to input a line from the player and find the significant words in it using a vocabulary table, save the game situation on a disk or tape, restore a situation saved previously, quit playing or start afresh.

Z-code format:

Each Z-code instruction begins with a byte containing the operation code, which includes bits describing how the operands (or arguments) are addressed. Some operations always use a certain number of operands, and some operations use an unpredictable number of operands, from zero to four. Each operand that is used can be either a "small" (8-bit) integer, a "large"

How to write An Adventure

Greg Hassett



As I gazed back at the crystal bridge that I had just crossed, I could hear water rushing nearby. My brass lantern was getting dim, and I knew that I would have to rest soon. The wisps of white mist danced before my eyes as if alive, and a sudden cold chill ran up my spine. I had with me a diamond necklace which I was determined to keep. A nasty dwarf emerged from the gloom. He threw a sharp knife at me! I grabbed my axe and heaved it at him. His body vanished in a cloud of greasy black smoke. My lamp was now out; I would have to search for batteries tomorrow in the dark. So I put my necklace in my small leather sack and called it a day.

I did not lie down on the cavern floor and go to sleep. I merely turned off my home computer. I had been playing a game called "Adventure." In this game, you explore a network of caves and pits in search of priceless treasure. This game is not the type of game which is mastered in an hour. It may take days, weeks, or even months to complete an Adventure.

This "original Adventure," developed at Stanford University a few years back by Willie Crowther and Don Woods, required large amounts of disk storage space. This made it very difficult to convert to run on a personal computer. However, other versions of Adventure have sprung up in the past year that are specifically designed to fit in the smaller machines.

To play Adventure, you enter commands to the computer in one or two word sentences in what seems to be English. A typical command might be "INSERT COIN" or "GET NECKLACE." To move about, you use commands such as "GO NORTH" or

enter a new "location," a new room description will be displayed. An example of such a description might be:

I AM IN A RADIANT CAVERN FORTY FEET HIGH. THE WALLS AND FLOORS ARE MADE OF SMOOTH MARBLE. THE POOLS OF CLEAR WATER ON THE FLOOR INDICATE AN OPENING HIGH ABOVE ME. UP ON THE CEILING GLOWS AN EERIE RED LIGHT.

AROUND ME I SEE: POOLS OF WATER. SMALL PLASTIC VIAL.

Later on in the game, the vial might come in handy for holding some liquid etc., so in this situation it might be wise to "GET VIAL."

The one thing that I feel makes Adventuring so interesting is the clues that are given as you explore.

Knowing that clues exist is one thing; isolating them and figuring out what they mean is quite another. In

Adventure, clues exist everywhere. They are in the room descriptions, the object descriptions. Let's say you enter a room where there are many stalactites, but no stalagmites on the floor. This in itself is a clue. If you think about it, stalagmites could be worn off if creatures lived there and walked through the cavern. But stalactites would not be destroyed because most creatures cannot reach them.

Then these are the type of clues which have to be decoded. As an example, take the clue "MAGIC BREAK WORD BOTTLE BIMBO." This clue makes no sense at first glance. But then you notice that if you read alternate words of the clue, it deciphers into "MAGIC WORD BIMBO" and "BREAK BOTTLE."

Magic words are very popular in Adventure. A common use for these words is movement. They might be the only way to get a completely different

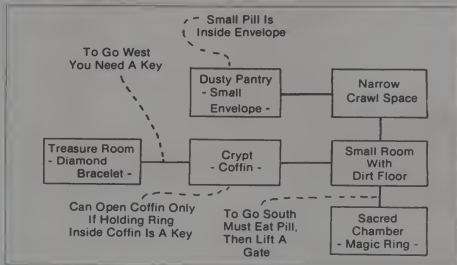


Figure 1. A typical portion of an Adventure map. Note that to get into the treasure room for the diamond bracelet, you must get the magic ring. To get the magic ring, you must eat the pill then lift a gate. To eat the pill, you must open the envelope found in the dusty pantry.

area of the Adventure. One such example, in one Adventure the magic word "BIMBO" will magically take you from being lost in the maze of caves to a small jungle on the other side of the island. And there is no other way to get there.

In this way, Adventure is like a good mystery novel, with you being the ace detective. On the other hand, Adventure can be nerve-wracking, frustrating, and the source of serious insomnia. Adventure is a sort of puzzle.

You have to fit all the pieces together to make it work.

I was first introduced to Adventure a few years back on a Digital Equipment Corporation PDP-11/70. I took an immediate liking to the game, but I didn't have any computer. When I purchased my Radio Shack TRS-80, I immediately set out to write an Adventure. The result was *Journey to the*

Center of the Earth, my first. When I found out I could sell this, I wrote six other Adventures: *The House of Seven Gables*, *Entry into King Tut's Tomb*, *Sorcerer's Castle*, *Voyage to Atlantis*, *Enchanted Island*, and *Enchanted Island-Plus* (a machine-language version with additional features).

If there's one thing that's more habit-forming than playing Adventures, it's writing them.

Writing Adventures

In the following paragraphs, I will attempt to outline the basic structure of the way Adventure can be written in Basic.

The first step in writing a Basic Adventure is coming up with the plot. This means answering the questions:

"Where will the Adventure take place?"

"What will be the main purpose of the Adventure?"

"In what kind of world is this supposedly happening?"

"What types of obstacles will the player have to overcome?"

"How is the player going to get by these obstacles?"

Once these five questions are answered in your mind, you begin to draw the map of the Adventure. The general form of the map is shown in Figure 1. Once you have about 40 rooms (more if you are in machine language), you are ready to begin keying in the DATA. The way I do this is in the form:

```
line# DATA "room description",
      n,e,s,w,u,d
```

where line# is the Basic statement number, "room description" is the description of the room, n is the room north of it, e is the room east of it, s is the room south of it, etc. If n,e,s,w,u,d are set to zero, then there is no way to

Each verb has its own special "verb routine" which is called after the parsing routine. For each verb, only a few nouns would make sense; for the "EAT" routine, "CHAIR" would have no meaning.

go from that room in the corresponding direction.

The objects are set up somewhat differently. They are in the form:

```
line# DATA "object", (room), (value)
```

where line# is the Basic statement number, "object" is the description of the object, (room) is the room where the object resides at the start of the Adventure, and (value) [if the Adventure has treasures and points] is the number of points that the object is worth. If (room) is set to zero, then the object is currently nowhere. For instance, if a trap door is only revealed after the command "MOVE RUG" is executed, the starting room for the "TRAP DOOR" is zero. Later on, after the rug is moved, the trap door's room gets set to some number other than zero.

During the initial setup of the Adventure, the program READS all of this DATA into arrays P(x), P(x,y), OB(x), and OB(x,y). P(x,y) holds the room description of room x. P(x,y) holds the room adjacent to room x in direction y. Direction 1=North, direction 2=East, direction 3=South, direc-

```
1000 'BASIC ROUTINE TO DISPLAY ROOM & ITS CONTENTS
1010 '
1020 'UPON ENTRY:
1030 'CP=THE CURRENT PLACE IN THE ADVENTURE
1040 'LD=THE MAXIMUM NUMBER OF OBJECTS IN THE ADVENTURE
1050 'D8(1)="NORTH", D8(2)="SOUTH", D8(3)="EAST"
1060 'D8(4)="WEST", D8(5)="UP", D8(6)="DOWN"
1070 '
1080 '
390 CLS 'CLEAR SCREEN
1100 PRINT P$CP: 'PRINT THE ROOM DESCRIPTION
1110 FOR I=1 TO LD 'THIS ROUTINE WILL PRINT ALL OBJECTS IN ROOM
1120 IF OB(I)=0 THEN PRINT D8(1) 'IN ROOM? YES... PRINT IT
1130 NEXT I 'GO ON TO THE NEXT OBJECT
1140 FOR I=1 TO 6 'THIS ROUTINE WILL PRINT ALL POSSIBLE DIRECTIONS
1150 IF P$CP(I) < 0 THEN PRINT D8(I) 'NOT ZERO? YES, PRINT D8(I)
1160 NEXT I 'GO ON TO NEXT DIRECTION
1170 PRINT STR$(63) "-" 'PRINT BAR ACROSS SCREEN
1180 RETURN 'RETURN
```

Listing 1—Basic listing of how the "display room" routine works. Note that all arrays must be set up as described in the text. The OB(x,y) array holds the rooms of object x. Note line 1120 where this value is compared with the current room number. Each object is "tested" in this fashion.

HELPFUL TIPS FOR PLAYING ADVENTURE GAMES

If an Adventure is getting you very frustrated, the best thing to do is shut down the machine and try again a little bit later. If you are determined to get by the frustrating obstacle, call up a friend. He/she might have some ideas which you would never think of! If no friends are available, apply as much common sense as possible. If this fails as well, try obscure reasoning and make irrational decisions.

Watch out for any words in "quotes" or with "stars" around them. These usually are clues. Any clue can be figured out if enough thought is put into it. Try reversing all of the letters of a particular clue. It can transform something as obscure as "ARBADAC ARBA" into something meaningful like "ABRA CADABRA."

Remember that not every obstacle can be overcome! A window that cannot be opened or broken is probably just there to confuse the player. So, if it seems impossible to get by, it probably is.

Another reason why you may not be able to get by an obstacle is that you do not have the necessary resources! For instance, to break a window, you may need a hammer! If you have never encountered the hammer before, you may not even know that it exists, and you may spend more time trying to get by it without the hammer that you will spend finding the hammer!

Do not be afraid to try things that are seemingly stupid! In many cases a command that seems dumb turns out to be the way to overcome the obstacle.

Periodically (every 15 minutes or so) save your game out to tape or disk with the command "SAVE" or "SAVE GAME." This will insure that in the case of a fatal accident you only lose about 15 minutes of adventuring. Make absolutely sure that you save your game before trying things with unknown results, such as drinking strange bubbling liquids or jumping off a cliff!

Adventure, cont'd...

tion 4=West, direction 5=Up, and direction 6=Down. Also, after all of the room and object DATA has been read, the program proceeds to READ the vocabulary tables into arrays NOS(x) and VBS(x). The vocabulary is stored in this manner:

```
line# DATA noun1,noun2,noun3,  
        noun4,...nounx  
line#2 DATA verb1,verb2,verb3,  
        verb4,...verbx
```

where line# and line#2 are Basic statement numbers, noun1-nounx are the vocabulary entries to be read into NOS(x) [nouns], and verb1-verbx are the vocabulary entries to be read into VBS(x) [verbs].

When the player enters a new room, the short routine in Listing 1 is executed. This will print the room description, its contents, and all possible directions leading out.

Parsing

Now that the Data Structure has been discussed, it becomes necessary to explain the parsing routine. This is the routine which will take the player's input, divide it into a verb/noun combination, compare it with the vocabulary tables, and return with two

numbers, stored in the variables VB and NO, each representing the offset in the vocabulary array. For instance, let's assume that "EAT" is verb number 28 [VBS(28)="EAT"] and "CHAIR" is noun number 12 [NOS(12)="CHAIR"]. If the player inputs "EAT CHAIR" as his command, the parsing routine would get called, and upon return, NO would equal 12 and VB would equal 28. The main part of the program would then deal with these two numbers. Depending on the number stored in VB upon return from the parsing routine, the main part of the program would then jump to a verb routine.

If there's one thing that's more habit-forming than playing Adventures, it's writing them.

Verb Routines

Each verb has its own special "verb routine" which is called by a large ON GOTO statement executed after the parsing routine. For each verb, there are usually only a few nouns which would make sense. For instance, for the "EAT" routine, "CHAIR" would have no meaning. In all

probability, only the noun "FOOD" would make any sense with "EAT." If any other noun was entered, the message "DON'T BE RIDICULOUS" would be output, and control would return to the input/parsing routine. If the noun was "FOOD," then the room# for the food would be set to zero [the food is non-existent once it has been eaten] and the message "MMM, GOOD." would be output. Control would then be transferred back to the input/parsing routine. □

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CIRCLE 151 ON READER SERVICE CARD

Genetic Engineering



Dick Straw

Have you ever thought you would like to be a genetic engineer? You know, someone with the skills and techniques to make plants and animals to your own designs? Or to eliminate some wasteful genetic disease by skillfully manipulating the hereditary material?

The means for accomplishing real genetic engineering are still not

The means for accomplishing real genetic engineering are still not available, although biologists get closer and closer each year.

available, although biologists working in that field get closer and closer each year. With the CODON program that follows, you can simulate some of the hoped-for techniques, however, and get some ideas about how the genes do their work. If you can use the biology teacher, you can use the program to help students learn some of the basics of molecular biology as well.

Even if you are just an ordinary programming buff without much concern for genetic engineering or molecular biology, the CODON program might still be of interest to you because of the string-handling routines involved. They show off some important ways that the Basic lan-

guage is, I feel, superior to Fortran, which handles strings only with difficulty. (Calm the hackles, friend — I use Fortran a lot too, when its advantages are needed!)

In addition, there is a segment that will direct all input and output to the printer without modifying the program to use LPRINT statements. (I owe this idea to Charles Butler, from an article in *Personal Computing*.)

This is not the place for an extended lesson in molecular biology. Almost all recent high school and college general biology books will give a good and more complete description of the details. A book called *Invitation to Biology* by Helena Curtis, used widely for college biology courses taken by non-specialists, is a good example. For a more detailed and superbly written account, try James Watson's (of double helix fame) book, *The Molecular Biology of the Gene*. Still, a very brief account might make the program more interesting.

Practically all the work of the cell is accomplished by proteins. These proteins are large and complex molecules made up of twenty elementary building blocks called amino acids. The numbers, kinds and order of the amino acids determine the shape and thus the function of the protein. Think of them, if you will, as factory "jigs" that hold things together so a needed chemical operation can be carried out. What molecules the proteins hold and what they do with them is determined entirely by the arrangement of their amino acids. Whether the cell or individual survives depends on what they do and how well, however.

Richard M. Straw, 2100 Maiden Lane, Altsadena, CA 91001.

Genetic, cont'd...

What kinds of jigs the cellular factory makes is determined by the kinds of genes in the nucleus of the cell. You can think of genes as the specifications for building jigs. Every time a new factory (cell) is built, the jig-specifying genes are copied and passed on to it from the previous cell. Every time a new individual (a new person or flower, full of cell-factories) is produced, the cells in it get a portion of the genes from each parent and can make new combinations of jigs. This determines the individual's unique characteristics. But the genes are not used directly — they are first copied into "blueprints" to be used in the factory itself, outside the nucleus, where the genes are never allowed to go.

The genes are really coded structures made up of four kinds of molecules called "bases," put together into a complex structure called a nucleic acid. A certain length of the kind of nucleic acid found in chromosomes, called DNA, is a single gene, and it carries the specifications for a single protein to be built. The blueprints are copies of this genetic information in a second kind of nucleic acid, RNA, which also carries its message in the arrangements of four sub-units. These sub-unit bases are the chemical molecules called adenine, cytosine, guanine, and uracil, and are referred to by their initials. Remember that their order is a code that specifies the organization of a particular protein with a specific function.

Three are terminators and give a STOP message that cuts off the protein building at that point.

When the blueprint-RNA is shipped out into the cell's factory, it is operated on by a cellular structure that reads the message in a very special manner, much as a film-strip projector shows the film one frame at a time. The frames in this case contain three of the bases at a time, and each set of three bases in a row is called a codon — the smallest piece of information in the RNA message. Recall that there are twenty kinds of amino acids but only four kinds of bases. This means that the smallest quantity of coded information that can translate a code of four symbols into another of twenty symbols must have a minimum of three symbols per unit. (There is an exercise

in combinatorics for you.) Each codon of the RNA is thus equivalent to one amino acid (except for three that are terminators and give a STOP message that cuts off the protein building at that point). With four symbols taken three at a time in specific order, there are 64 kinds of codons. Since there are only twenty amino acids, you get a lot of synonyms (called redundancy), but that has its advantages too.

Mutations are changes in the structure of the genes that, by way of the messenger RNA, are translated into incorrectly built proteins. These "bad" proteins usually either do something wrong or do not do whatever they were supposed to do. Either of these can upset the functioning of the cell and the individual. Thus things that cause mutations, like radiation and many kinds of chemicals, are bad for the health also.

You have three options: you can change one base in the message to another, or insert some more bases into the list, or take out some bases.

Enough of that. Let's look at what the program does.

Briefly, CODON invites you to enter a sequence of base initials, A, C, G or U, in any order you desire up to a total of 150 in order to three lines. Short examples do as well as long ones, usually. This message is then echoed back to you in codon-groups, three letters at a time, as shown in Figure 1.

```
RNA MESSAGE NOW READS (BY CODONS):  
AUC AUC AUC AUC AUC AUC  
YOUR INPUT STRING TRANSLATES TO:  
ILE-ILE-ILE-ILE-ILE-ILE-
```

Figure 1 The original input string of RNA bases is echoed in codon groups of three bases and translated into the corresponding amino acid string. Only one codon type is used to make the changes more evident.

Here, a simple sequence repeating the codon AUC was used. The program then translates that RNA message into the corresponding sequence of amino acids it would produce in the cell. In the example, AUC translates into a sequence of the amino acid, isoleucine, abbreviated by the letters ILE. If you look at lines 7160-7250 you will see the abbreviations used, which will be printed for you if you ask for information at the beginning of the program. See the full sample run, too.

You then have three options (other than stopping): you can change one

```
RNA MESSAGE NOW READS (BY CODONS):  
AUC AUC AUC AUC AUC AUC  
PROTEIN HAS NOW BECOME:  
ILE-ILE-THR-ILE-ILE-ILE-
```

Figure 2 The base at position 8 (indicated by an arrow) was changed from U to C, and the resulting amino acid string has one different acid because of this mutation.

base in the message to another, or insert some more bases into the list, or take out some bases. Figure 2 shows what happens when you change base number 8 from U to C. One amino acid in the structure is changed this time, from ILE to THR, or threonine. This simple mutation, representative of the smallest genetic change possible, can be extremely important. The only difference between the normal hemoglobin that most of us have in our cells and the sickle-cell hemoglobin that can kill its carriers through severe anemia is just such a single amino acid substitution, putting in valine instead of the glutamic acid that is usually present. The RNA message change was probably putting a U where an A belonged.

Figure 3 shows what happens when you add a single base. If you

```
RNA MESSAGE NOW READS (BY CODONS):  
AUC AUC CAC CAU CAU CAU C  
CURRENT PROTEIN READS:  
ILE-ILE-HIS-HIS-HIS-HIS-
```

Figure 3 A new base, C, was inserted into the string after position 6, with the result that the whole message has changed beyond the position of the insertion. Note also that two different codons have been translated into one amino acid — an example of code redundancy.

examine the sequence, you will find that a new C has been stuck into the sequence at position 7. The list is now one base longer, but the program does not translate the stray end. Two things will be apparent. First, you can see that the whole protein after the insertion has been changed — to a sequence of histidines (HIS). Secondly, the third and fourth codons, CAC and CAU, both translate into HIS, an example of the code redundancy.

If you now take out a base, number 13 in the example, you get the results shown in Figure 4. Here you can see

```
RNA MESSAGE NOW READS (BY CODONS):  
AUC AUC CAC CAU AUC AUC  
PROTEIN NOW HAS THIS STRUCTURE:  
ILE-ILE-HIS-HIS-ILE-ILE-
```

Figure 4 The arrow indicates the position (#13 of the previous one) from which a base, C, was removed. This causes the amino acid chain to be different between the two changes made, compared to Figure 1, but the same both before and after them.

that there is a place in the sequence between the insertion and the deletion that is different from the original, but both ends are back to where you started. It was by using techniques like this that Nobel prizewinner Francis Crick demonstrated that codons really were three bases long — adding three or taking out three bases leaves the protein between modified but the ends the same. If the modified length is not

Each set of three bases in a row is called a codon — the smallest piece of information in the RNA message. There are twenty kinds of amino acids but only four kinds of bases.

too great, the protein may still function partly — depending on a lot of things. In general, however, any mutations cause problems that may vary from insignificant to great.

Each of the parts of the program is marked by REM lines so that it should be easy to follow. The codon dictionary (found in the data lines 6000 to 6080) is read into array C by lines 150 — 170. It is used to translate the RNA message. If your version of Basic does not accept three-dimensional arrays some rewriting will be needed here. Notice also that I used the DEFSTR (define string) and DEFINIT (define integer) functions of the TRS-80 Basic to declare the types of several variables ahead of time. At least the C's, A's and S's in the program would need to be changed to C's, etc., if you do not have this capacity. Also permitted here, but perhaps not by your interpreter, is the reading of string data without quotation marks from lines 6000 - 6080.

The program segment in lines 211 to 216 allows you to divert all input and output to the printer if you wish. If you answer "yes" to the first question, the two pairs of PEEK statements pick up the addresses of the video driver (VL% and VH% — low and high bytes) and printer driver (PL% and PH%), and then two POKES put the printer driver address where the video driver address usually resides. When you stop the run (at lines 510-530, by selecting option 4 from the menu), the video addresses are restored to their proper places. The complete run example was produced by this option. It is best not to stop the program with the <BREAK> key.

The routine at lines 340-390 reads

in your input string and puts together a long one, C1. The echo routine at subroutine 8700 puts the input string C1 into string C5 and lists the input string by codons. String C5 has spaces inserted between the groups of three bases, which are not wanted by the translating routines.

Translating is done by the subroutine beginning at 8000, which in turn calls another at 8200. The second translates the letters of each successive codon in your input string into numbers by which to access the array C, and the prime subroutine builds another string, A, which is then printed out by the subroutine at 8500. In both printing subroutines line lengths are controlled so a uniform and neat output is produced. The whole program is written for video display; but, as noted above, output can be sent to the printer if you wish.

The segments that insert or delete strings of bases into the original (or any subsequent) string start at lines 2000 and 3000. All they do is find out what location is desired, break the original string into the two ends needed, and put in or take out what you request. If you ask to delete beyond the end of the string, the end is cut off and the extra "deletion" is ignored. You can't delete more than the whole string, though.

Figure 5. A full run of the program using the printer option, including the information that is optionally provided.

```
DO YOU WANT INFORMATION AND INSTRUCTIONS? Y
MESSAGE RNA IS A COPY OF THE GENETIC INFORMATION IN
THE DNA OF THE GENE IN THE CHROMOSOME. THE ORDER OF THE
YOUR BASES (A = ADENINE, C = CYTOSINE, G = GUANINE, AND
U = URACIL) DETERMINES THE ORDER OF THE AMINO ACIDS IN
THE PROTEIN. THAT ORDER REGULATE THE FUNCTION OF THE
PROTEIN IN THE CELL.
YOU MAY ENTER A STRING OF BASES TO SIMULATE THE
STRUCTURE OF THE RNA MOLECULE. USE ONLY THE LETTERS,
A, C, G, AND U, AND LEAVE NO SPACES. IF YOU WANT MORE
THAN ABOUT 50, USE 2 OR 3 LINES BUT DO NOT ENTER MORE
THAN 150 BASES IN ALL.
DO YOU WANT MORE INFORMATION? Y
EACH GROUP OF THREE BASES IN THE MESSAGE IS CALLED A CODON.
EACH CODON TRANSLATES INTO ONE AMINO ACID IN THE PROTEIN.
THE AMINO ACID ASSOCIATIONS ARE:
ALA = ALANINE LAU = LEUCINE
ARG = ARGinine LYS = LYSINE
ASN = ASPARAGINE MET = METHIONINE
ASP = ASPARTIC ACID PHE = PHENYLALANINE
CYS = CYSTEINE PRO = PROLINE
GLU = GLUTAMINE TRP = Tryptophan
GLY = GLYCINE VAL = VALINE
HIS = HISTIDINE TYR = TYROSINE
ILE = ISOLEUCINE
READY? Y
YOU MAY NOW ENTER AN RNA MESSAGE.
ENTER NO MORE THAN THREE LINES OF DATA NOR MORE THAN 150
BASES IN ALL. USING ONLY LETTERS A, C, G, AND U
RESPOND TO "I" WITH ENTERS IF DONE WITH INPUT.
? ACCGUGACUAGUACAUAGC
LENGTH IS 30
RNA MESSAGE NOW READS (BY CODONS):
ACC GUG CAC GAG GUC AAU CG
YOUR INPUT STRING TRANSLATES TO:
TER-VAL-HIS-GLU-VAL-ASP-
YOU CAN MAKE ANY OF THESE CHANGES:
1. CHANGE ONE BASE IN THE LIST.
2. INSERT ONE OR MORE ADJACENT BASES.
3. DELETE ONE OR MORE ADJACENT BASES.
OR STOP (TYPE 4)
WHICH DO YOU CHOOSE? 1
CHANGE A SINGLE BASE IN RNA MESSAGE
CHANGE WHICH BASE (NUMBER)? 10
BASE NUMBER 10 IS NOW U
WHAT BASE DO YOU WISH TO CHANGE IT TO? C
RNA MESSAGE NOW READS (BY CODONS):
ACC GUG CAC GAG GUC AAU CG
PROTEIN NOW HAS 8 RESIDUES:
TER-VAL-HIS-GLU-VAL-ASP-
YOU CAN MAKE ANY OF THESE CHANGES:
1. CHANGE ONE BASE IN THE LIST.
2. INSERT ONE OR MORE ADJACENT BASES.
3. DELETE ONE OR MORE ADJACENT BASES.
OR STOP (TYPE 4)
WHICH DO YOU CHOOSE? 3
DELETE BASES FROM RNA MESSAGE
HOW MANY BASES DO YOU WISH TO REMOVE? 4
DELETE BEGINNING WITH WHICH BASE (NUMBER)? 5
RNA NOW HAS 27 BASES
RNA MESSAGE NOW READS (BY CODONS):
ACC CGC AGG UUA AUC CAA GGU UUA CGC
PROTEIN NOW HAS 9 RESIDUES:
TER-ALA-ARG-LEU-GLN-GLY-LEU-PRO-
YOU CAN MAKE ANY OF THESE CHANGES:
1. CHANGE ONE BASE IN THE LIST.
2. INSERT ONE OR MORE ADJACENT BASES.
3. DELETE ONE OR MORE ADJACENT BASES.
OR STOP (TYPE 4)
WHICH DO YOU CHOOSE? 4
```

The program is written in Disk Basic, but the only unique feature is used in line 1060 of the change-a-base routine. This is the MID\$ function on the left side of an assignment statement. To convert to Level II Basic this line would need to be rewritten to use the techniques of the insert or delete

It was by using techniques like this that Crick demonstrated that codons really were three bases long.

methods. The following substitution for line 1060 will work:
1060 C2=LEFT\$(C1,K1-1):
C3=RIGHT\$(C1,L-K1):
C1=C2+A5+C3

It is the only change that should be needed, however, as everything else is standard usage.

With that amount of description, everything else should be easily followed. Most common mistakes (like entering an incorrect letter) are trapped, and lots of prompts and information are provided to make this an essentially independent program once its basic intentions are understood. □

Genetic, cont'd...

```

10 REM CODON PROGRAM
10 REM (C) DICK STRAWN 1980
10 REM TRN=80 DIBT BASIC
40 REM
100 CLEAR 2000
110 DEFECT C,A,B: DEFINT I=N
120 DIM C(4,4)
130 FOR J=1 TO 4:FOR I=1 TO 4: FOR K=1 TO 4
140 READ C(I,J,K)
150 NEXT K,J,I
160 C$(4)=$1234:"CODON PROGRAM"
170 PRINT:PRINT"SIMULATES TRANSLATION OF MESSENGER-RNA INTO PROTEIN"
180 PARAB: INPUT"DO YOU WANT TO OUTPUT TO PRINTER?";B1
190 IF ASC(B1) < 49 GOTO 210
210 PAR=1: INPUT"WHEN PRINTER IS READY, PRESS ENTER";B1
220 K$=PEEK(164211): P$=PEEK(164213)
230 V$=PEEK(164141): V$=PEEK(164143)
240 P$=PEEK(164145): P$=PEEK(164147)
250 PRINT:INPUT"DO YOU WANT INFORMATION AND INSTRUCTIONS?";B1
260 IF ASC(B1)=89 THEN GOTO 7000
280 REM START MAIN PROGRAM
290 PRINT:PRINT"YOU MAY NOW ENTER AN RNA MESSAGE."
310 PRINT:ENTER NO MORE THAN THREE LINES OF DATA NO MORE THAN 150"
320 PRINT:BASSES IN ALL, USING ONLY LETTERS A, C, G, AND U"
330 PRINT:RESPOND TO '?' WITH '<ENTER>' IF DONE WITH INPUT."
340 C$=""
350 FOR I=1 TO 3
360 C$+"" INPUT C
370 IF C$="" GOTO 400
380 C$+C
390 NEXT I
400 L=LEN(C): PRINT"LENGTH IS";L
410 GOSUB 5700
420 PRINT:PRINT"YOUR INPUT STRING TRANSLATES TO:"
430 GOSUB 5800
440 GOSUB 5900
450 PRINT:PRINT"YOU CAN MAKE ANY OF THESE CHANGES:"
460 PRINT" 1. CHANGE ONE BASE IN THE LIST."
470 PRINT" 2. INSERT ONE OR MORE ADJACENT BASES."
480 PRINT" 3. DELETE ONE OR MORE ADJACENT BASES."
490 PRINT" OR STOP (TYPE 4)"
500 INPUT"WHEN DO YOU CHOOSE?";N
510 ON N GOTO 1000, 2000, 3000, 510
520 IF N#4 GOTO 530
530 P$=PEEK(164145): P$=PEEK(164147)
540 STOP
550 REM CHANCE ONE BASE
1000 PRINT:PRINT"CHANGE A SINGLE BASE IN RNA MESSAGE"
1010 PRINT:INPUT"CHANCE WHICH BASE (NUMBER)";K
1020 IF K#1 OR K#2 OR K#3 OR K#4 GOTO 1030
1030 A$=MID$(C,K,1)
1040 PRINT:PRINT"BASE NOW IS";A$: IS NOW "AS
1050 INPUT"WHAT BASE DO YOU WISH TO CHANGE IT TO?";A$
1060 MID$(C,K,1)=A$
1070 GOSUB 5710
1080 PRINT RNA

```

Program Listing

```

1080 PRINT:PRINT"PROTEIN HAS NOW BECOME."
1090 GOSUB 8000
1100 GOSUB 8500
1110 GOTO 440
1180 REM INSERT BASES
2000 PRINT:PRINT"INSERT BASES INTO RNA MESSAGE"
2010 PRINT:AS="" INPUT"ENTER STRING OF BASES TO INSERT."
2020 INPUT A$
2030 L=LEN(A$): IF L#>150 PRINT"TOO LONG" GOTO 2010
2070 INPUT"INSERT AFTER WHICH BASE (NUMBER)";B1
2080 IF B1#1 PRINT"NOT A VALID LOCATION - PART END" GOTO 2070
2090 C$(B1)=C$(B1)+A$
2100 C$=RIGHT$(C$,123)
2110 C$=C$(C$+LEN(C$)-LEN(C$))
2120 PRINT"RNA NOW HAS";L+1" BASES"
2140 GOSUB 8700
2150 PRINT:PRINT"CURRENT PROTEIN READS:"
2160 GOSUB 8800
2170 GOSUB 8900
2180 GOTO 440
2190 REM REMOVE BASES
3000 PRINT:PRINT"DELETE BASES FROM RNA MESSAGE"
3010 INPUT"HOW MANY BASES DO YOU WISH TO REMOVE?";L2
3020 IF L2 < 0 PRINT"RNA IS NOT THAT LONG" GOTO 3010
3030 PRINT:PRINT"DELETE BEGINNING WITH WHICH BASE (NUMBER)";K1
3040 IF K1#1 OR K1#2 OR K1#3 OR K1#4 GOTO 3040
3050 C$=LEFT$(C$,K1-1)+C$(K1+L2)
3060 C$=C$(C$+LEN(C$)-LEN(C$))
3070 PRINT"RNA NOW HAS";L+L2" BASES"
3080 GOSUB 8700
3090 PRINT:PRINT"PROTEIN NOW HAS THIS STRUCTURE:"
3100 GOSUB 8800
3110 GOSUB 8900
3120 GOTO 440
4000 END
4001 REM
6000 REM CODON DICTIONARY
6010 DATA PHU, PHE, LEU, LEU, LEU, SER, SER, SER, SER, SER
6020 DATA TYR, TYR, STOP, STOP, CYS, CYS, STOP, STOP
6030 DATA LEU, LEU, LEU, LEU, PRO, PRO, PRO, PRO, PRO
6040 DATA HIS, HIS, GLU, GLU, ARG, ARG, ARG, ARG, ARG
6050 DATA LEU, LEU, LEU, MET, THR, THR, THR, THR, THR
6060 DATA ASP, ASP, LEU, LEU, SER, SER, ARG, ARG, ARG
6070 DATA VAL, VAL, VAL, VAL, ALA, ALA, ALA, ALA, ALA
6080 DATA ASP, ASP, GLU, GLU, GLY, GLY, GLY, GLY, GLY
6090 REM
7000 REM INFORMATION TEXT
7010 PRINT:PRINT"THIS PROGRAM IS A COPY OF THE GENETIC INFORMATION"
7020 PRINT"THE DNA OF THE GENE IN THE CHROMOSOME, THE ORDER OF THE"
7030 PRINT"FOUR BASES (A = ADENINE, C = CYTOSINE, G = GUANINE, AND"
7040 PRINT"U = URACIL) DETERMINES THE ORDER OF THE AMINO ACIDS IN"
7050 PRINT"THE PROTEIN. THAT ORDER REGULATES THE FUNCTION OF THE"
7060 PRINT"CELL."
7070 PRINT:PRINT"YOU MAY ENTER A STRING OF BASES TO SIMULATE THE"
7080 PRINT"STRUCTURE OF THE RNA MOLECULE. USE ONLY THE LETTERS"
7090 PRINT"A, C, G, AND U, AND LEAVE NO SPACES. IF YOU WANT MORE"
7100 PRINT"THAN ABOUT 50, USE 2 OR 3 LINES BUT DO NOT ENTER MORE"
7110 PRINT"THAN 150 BASES IN ALL."
7120 PRINT:INPUT" DO YOU WANT MORE INFORMATION?";B1
7130 IF ASC(B1) < 49 THEN RETURN
7140 PRINT:PRINT"EACH GROUP OF THREE BASES IN THE MESSAGE IS CALLED A CODON."
7150 PRINT"EACH CODON TRANSLATES INTO ONE AMINO ACID IN THE PROTEIN."
7160 PRINT:PRINT"THE FOLLOWING ARE THE AMINO ACIDS."
7170 PRINT:PRINT"ALA = ALANINE LEU = LEUCINE"
7180 PRINT:PRINT"ARG = ARGinine LYS = LYSINE"
7190 PRINT:PRINT"ASP = ASPARAGINE MET = METHIONINE"
7200 PRINT:PRINT"CYS = CYSTEINE PHE = PHENYLALANINE"
7210 PRINT:PRINT"GLN = GLUTAMINE PRO = PROLINE"
7220 PRINT:PRINT"GLU = GLUTAMIC ACID SER = SERINE"
7230 PRINT:PRINT"GLY = GLYCINE THR = THREONINE"
7240 PRINT:PRINT"HIS = HISTIDINE TRP = TRYPTOPHANE"
7250 PRINT:PRINT"ILE = ISOLEUCINE VAL = VALINE"
7260 INPUT "Ready?"
7270 RETURN
7999 REM
8000 REM TRANSLATING ROUTINE
8010 A$="": FOR I=1 TO L STEP 3
8020 C$="" C$=MID$(C,I,3)
8025 IF LEN(C$) < 3 GOTO 8130
8030 A$=LEFT$(C$,3): GOSUB 8200
8040 J$="J: IF J#0 GOTO 8130
8050 A$=MID$(C$,2,1): GOSUB 8200
8060 J$="J: IF J#0 GOTO 8130
8070 A$=RIGHT$(C$,1): GOSUB 8200
8080 J$="J: IF J#0 GOTO 8130
8090 A$=C$(J+2,3): A$=A$+A$
8100 IF J#0 PRINT"BAD BASE IN CODON AT POSITION";I+1" - (C)"
8110 NEXT I
8120 RETURN
8130 REM
8200 REM DECODING BASES TO DICTIONARY INDICES
8210 J$="J: IF J#0 THEN J$=1: GOTO 8250
8220 IF A$="C" THEN J$=2: GOTO 8250
8230 IF A$="A" THEN J$=3: GOTO 8250
8240 IF A$="G" THEN J$=4
8250 RETURN
8500 REM PRINT PROTEIN
8510 IF LEN(A) < 57 THEN PRINT:PRINT A: RETURN
8520 A1=LEFT$(A,56)
8530 A2=MID$(A,57,56): A$="": A$=""
8540 IF LEN(A1) > 112 THEN A$=MID$(A1,113,56)
8550 IF LEN(A2) > 188 THEN A$=MID$(A2,189,56)
8560 PRINT:PRINT A1: PRINT:PRINT A2
8570 IF LEN(A1) > 0 THEN PRINT:PRINT A1
8580 IF LEN(A2) > 0 THEN PRINT:PRINT A2
8590 RETURN
8700 REM PRINT RNA MESSAGE
8710 PRINT:PRINT"RNA MESSAGE NOW READS (BY CODONS):"
8720 C$="" FOR I=1 TO LEN(C1) STEP 3
8730 C$=C$(MID$(C1,I,3))
8735 NEXT I
8740 IF LEN(C$) < 57 THEN PRINT:PRINT C$: RETURN
8750 C$=LEFT$(C$,56): C$=MID$(C$,57,56): C$=""
8760 IF LEN(C$) > 112 THEN C$=MID$(C$,113,56)
8770 IF LEN(C$) > 188 THEN C$=MID$(C$,189,56)
8780 PRINT:PRINT C$: PRINT:PRINT C$
8790 IF LEN(C$) > 0 THEN PRINT:PRINT C$
8800 RETURN

```



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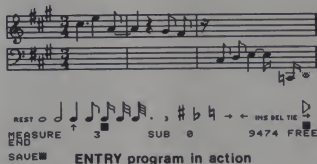
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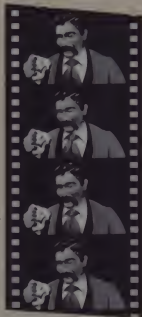
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The Electric Company

Ralph White



Game Description

THE ELECTRIC COMPANY is an economic game/simulation. The user is made president of the company for ten years — unless mismanagement forces earlier retirement.

At the beginning of year one, the company has one million dollars, 1600 tons of coal, 2500 barrels of fuel oil, one power plant and 700 customers. All power plants have a capacity of one million kilowatts. The user may choose which type of fuel to use at each power plant he owns — the one he starts with as well as each one that is built. Coal plants are more expensive to build than fuel oil power plants, but they are cheaper to operate.

If more than one power plant is owned, the amount of power generated can be divided between or among the plants in any fashion desired — as long as no plant generates more than one million kilowatts. The only requirement is that enough power be generated to meet demand. Demand is determined by the number of customers. In a normal year in the program each customer consumes one thousand kilowatts.

The kilowatt demand is displayed for the user. If more than one plant is being operated, the display will subtract the power you chose to generate from previous plants and displays only the remaining kilowatts needed to meet demand.

If the amount of power generated falls short of the customers' demand then a brown-out occurs. This does not terminate the game, but damage is done to the generators and the company is charged an amount of money for repairs. The more the generated amount of electricity is below the demand, the more it will cost to repair the damage.

If the kilowatt demand outstrips the generating capacity of the company, then the generators go "poof!" and the game is terminated.

As power plants get older, they become increasingly inefficient. Each year the president of the company has to decide whether or not to remodel the plant(s). To aid in making the decision, a print out of cost for each plant, the percent of increase in efficiency for

each plant, and total cost is shown. If the decision is to remodel, all plants are remodeled at the same time. The longer one waits to remodel, the more it will cost. The cost of remodeling is in part based on the increase of efficiency. Remodeling does not increase each plant's capacity. It makes each plant more efficient; it will use less fuel to make a kilowatt of electricity.

Very little in the program is allowed to remain constant. The population does not remain stable throughout the game. Each year, there is growth in the number of customers. Usually, the number of customers will increase at a rate that will require the building of a second power plant before the ten year term is completed.

Not only is the population not stable, but neither is the economy. An inflationary spiral is built into the price of all goods and services except one — the rate the company charges per kilowatt of electricity. As the program advances through each year, fuel, power plants, damage charges, etc. become more expensive.

Although the price per kilowatt the company gets for electricity does not automatically increase with inflation, a provision is made for applying for a rate increase each year. Rate increases are not allowed in two consecutive years. By waiting two years a rate increase request will be accepted if it is not too large. If it exceeds the upper limit defined by the program (which is tied to the Consumer Price Index), the request will be denied. If three or more years elapse between rate increases not only will the increase be accepted if it falls within the program's guide lines, but if it is too large, the program will yield a lesser compromise rate increase. Since an increase is not allowed every year, the upper limit for an allowable increase exceeds the Consumer Price Index.

Each year there is a 50 percent chance of some unforeseen event. These are not always bad or disastrous. Demand may rise a little faster or slower than usual, the company may be charged to repair storm damage to equipment, customers may be lost, additional customers may want to be hooked into the system (it costs the company a one-time fee to add these customers so the option of refusing service to them is given). If there are

any costs involved in any of the above events, they will be influenced by inflation also.

Not all decisions become effective immediately. When ordering coal and fuel oil there is a lead time of one year. The fuel does not become available for use until the following year. Enough fuel must be on hand to supply the current year's needs. The same lead time of one year applies to rate increases also.

Two reports are shown. The first report, at the beginning of each year, shows the cash reserve, coal and fuel oil amounts, number of customers and number of plants owned. The second report, at the end of each year, displays the gross income, the maintenance costs for the year (maintenance costs are influenced by number of plants being operated, number of customers being served and the Consumer Price Index), percent of generating capacity that is being used, the inflation rate for the past year and the consumer price index.

Program Notes

THE ELECTRIC COMPANY is written in Radio Shack Level II Basic and requires 11K of memory. The instructions and scenario (not shown in the sample run) are located in lines 90-500.

The left hand brackets in lines 1820 and 1830 are the line printer's representation of an exponential arrow. If the Basic you have access to does not support exponentiation, substitute $R \cdot \text{PI}^{\text{SOR}(\text{PI})}$. This yields the same result.

The "*" after some of the variables such as CR# indicates double precision. This prevents the output from appearing in scientific notation if the value of the variable exceeds six digits.

The strings defined in lines 10 and 20 are used in conjunction with the PRINTUSING statements to format the print-out of data by inserting dollar signs, commas and decimal points, or restricting numbers to two decimal places. If the PRINTUSING command is not available to you, the lines may be rewritten with only PRINT statements.

For those of you who wish to modify the degree of difficulty of the program, line 540 defines the initial values of the variables that are to be managed. □

```

10 DS="88888,888,888,88" XS="      888,888,888" CS="8888 88"
20 CS="88888,888 88"
30 CLS:PRINTCHR(223):PRINT-PRINT-PRINT
40 @B="*****"
50 PRINTM:PRINT-PRINT-PRINT
60 FOR%I=102000 NEXT
70 CLS:INPUT"DO YOU NEED INSTRUCTIONS (YES/NO) "Z%
80 IFZ%="NO"GO0070540
90 CLS:PRINT"YOU HAVE HIRED AS PRESIDENT OF AN ELECTRIC COMPANY."
100 PRINT"YOU WILL BE PRESIDENT FOR 10 YEARS BEFORE BEING NAMED TO THE"
110 PRINT"BOARD OF DIRECTORS--ASSUMING A SUCCESSFUL TERM AS PRESIDENT."
120 PRINT" YOU WILL START WITH ONE MILLION DOLLARS IN CASH, 1 POWER"
130 PRINT"PLANT AND STOCK PILES OF COAL AND FUEL OIL--THE TWO FUELS YOU"
140 PRINT"WILL USE TO POWER A GENERATING PLANT. YOU MAY CHOOSE EITHER"
150 PRINT"FUEL. YOU WISH TO POWER THE PLANT YOU START WITH AND EACH"
160 PRINT"GENERATING PLANT YOU BUILD THEREAFTER. ALL PLANTS HAVE A"
170 PRINT"GENERATING CAPACITY OF 1 MILLION KILOWATTS. AS THE PLANTS"
180 PRINT"BECOME OLDER, THEY BECOME INCREASINGLY INEFFICIENT. THAT IS,"
190 PRINT"THEY CONSUME MORE FUEL TO PRODUCE EACH KILOWATT OF ELECTRICITY."
200 PRINT"THEY CAN BE BROUGHT BACK TO PEAK EFFICIENCY BY REMODELING THEM."
210 PRINT"THE LONGER YOU WAIT TO REMODEL, THE MORE IT WILL COST. AND IF"
220 PRINT"MORE THAN ONE PLANT IS OWNED, ALL PLANTS MUST BE REMODELED MT"
230 PRINT"THE SAME TIME."
240 INPUT"PRESS 'ENTER' TO CONTINUE INSTRUCTIONS "Z%
250 CLS:PRINT"YOU HAVE TWO FUELS FROM WHICH TO CHOOSE: COAL AND FUEL OIL."
260 PRINT"COAL TENDS TO YIELD MORE KILOWATTS PER DOLLAR OF FUEL, HOWEVER,"
270 PRINT"COAL PLANTS COST ABOUT $65 MORE TO BUILD THAN FUEL OIL PLANTS."
280 PRINT"MANAGEMENT OF FUEL SUPPLIES IS IMPORTANT BECAUSE THERE IS A"
290 PRINT"LEAD TIME OF 1 YEAR BEFORE IT ARRIVES. COAL ORDERED IN YEAR"
300 PRINT"4 IS NOT AVAILABLE FOR USE UNTIL YEAR 5, SO A CLOSE EYE MUST BE"
310 PRINT"KEPT ON FUEL RESERVES."
320 PRINT" INFLATION AFFECTS THE COST OF ALMOST EVERYTHING YOU"
330 PRINT"ENCOUNTER. FROM FUEL COSTS TO DAMAGE CAUSED BY DISASTER OR"
340 PRINT"JUDGEMENT ERROR. IF YOU FIND THAT A RATE INCREASE IS REQUIRED"
350 PRINT"TO MAINTAIN A PROFITABLE BUSINESS AND KEEP THE STOCK HOLDERS"
360 PRINT"HAPPY, YOU MAY APPLY FOR A RATE INCREASE EACH YEAR. ALL YOU DO"
370 PRINT"IS SPECIFY WHAT YOU WANT THE NEW RATE TO BE (THE INITIAL RATE"
380 PRINT"IS .05 PER KILOWATT)."
390 PRINT"INPUT'PRESS 'ENTER' TO CONTINUE INSTRUCTIONS "Z%
400 CLS:PRINT" TEMPER YOUR RATE REQUESTS WITH MODERATION. GREED WILL"
410 PRINT"GET YOU NOWHERE. RATE INCREASES CAN BE REJECTED AS WELL AS"
420 PRINT"ACCEPTED. BY WAITING LONGER BETWEEN INCREASE REQUESTS, YOU"
430 PRINT"CAN ASK FOR A LARGER INCREASE AND HAVE IT ACCEPTED. ALSO BY"
440 PRINT"WAITING LONGER BETWEEN REQUESTS, A COMPENSATE RATE INCREASE MAY"
450 PRINT"BE GRANTED--BECAUSE AS FREQUENT REQUESTS MAY RESULT IN A DENIED"
460 PRINT"INCREASE. AS WITH FUEL ORDERS, THERE IS A LEAD TIME OF 1 YEAR"
470 PRINT"FOR RATE REQUESTS. A RATE INCREASE GRANTED IN YEAR 6 DOES NOT"
480 PRINT"TAKE EFFECT UNTIL YEAR 7."
490 PRINT"PRINT" NOW LIKE ALL GOOD EXECUTIVES, YOU MUST GET TO WORK."
500 CLS:PRINT" O O O D L U C K ! ! !"
510 DEFDIB=D,K,L
520 DEFDIB=D,K,L
530 PRINT"INPUT'PRESS 'ENTER' TO BEGIN "Z%
540 CLS:PRINT"***** FINANCES FOR BEGINNING OF YEAR "Y% *****:PRINT
550 CLS:PRINT"WHAT FUEL DO YOU WANT TO POWER THE GENERATORS OF YOUR PLANT?"
560 INPUT%I=COAL, 2=FUEL OIL "F(%I)
570 IF(1)<(1)<(ORF(1)>=20070550
580 EF(1)=1
590 V%="Y"
600 I=0
610 E=(100+RND(18))/100
620 I=1+(EF(1)-EF(1))%E:IF(1)<20070510
630 CLS:PRINT"***** FINANCES FOR BEGINNING OF YEAR "Y% *****:PRINT
640 PRINT"GENERATING PLANTS OWNED "I:PRINTIN%O%:OF
650 PRINT"NUMBER OF CUSTOMERS "I:PRINTIN%O%:CS
660 PRINT"TONS OF COAL IN STOCK "I:PRINTIN%O%:CL
670 PRINT"BARRELS OF FUEL OIL IN STOCK "I:PRINTIN%O%:FO
680 PRINT"COAL RESERVE "I:PRINTIN%O%:FO
690 PRINT"INPUT'PRESS 'ENTER' TO BEGIN THE YEAR'S TRANSACTIONS"Z%
700 IFCR%<20070780
710 CLS:PRINT"YOU HAVE BUNGLED THE JOB. THE COMPANY IS BROKE."
720 PRINT"YOU HAVE BEEN SENT TO A SIBERIAN SALT MINE TO COOL YOUR HEELS."
730 PRINT"00702200
740 PRINT"YOU HAVE MISMANAGED YOUR FUEL INVENTORY. THAT IS TOO BAD, FOR"
750 PRINT"YOU WERE DOING FINE IN OTHER AREAS OF MANAGEMENT. BUT THE"
760 PRINT"BOARD OF DIRECTORS WERE UNSYMPATHETIC. YOU WERE OWNED."
770 PRINT"00702200
780 I%=(100+RND(122))/100:P1=PI%I:P0=(100+RND(122))/100
790 I%=(100+RND(122))/100:P1=PI%I:P0=(100+RND(122))/100
800 CLS:PRINT"***** FINANCES FOR BEGINNING OF YEAR "Y% *****:PRINT
810 CLS:PRINT"WHAT FUEL DO YOU WANT TO POWER THE GENERATORS OF YOUR PLANT?"
820 INPUT%I=COAL, 2=FUEL OIL "F(%I)
830 E=(100+RND(18))/100
840 E=(100+RND(18))/100
850 CLS:PRINT"***** FINANCES FOR BEGINNING OF YEAR "Y% *****:PRINT
860 CLS:PRINT"WHAT FUEL DO YOU WANT TO POWER THE GENERATORS OF YOUR PLANT?"
870 PRINT"INPUT" WHAT IS YOUR DECISION "I%
880 PRINT"DO YOU WISH TO SELL POWER TO THEM?"INPUT%I=YES, 2=NO "DC
890 IFCDC<20070580
900 IFCDC<20070580
910 CLS:PRINT"***** FINANCES FOR BEGINNING OF YEAR "Y% *****:PRINT
920 CLS:PRINT"WHAT FUEL DO YOU WANT TO POWER THE GENERATORS OF YOUR PLANT?"
930 CLS:PRINT"WHAT FUEL DO YOU WANT TO POWER THE GENERATORS OF YOUR PLANT?"
940 CLS:PRINT"WHAT FUEL DO YOU WANT TO POWER THE GENERATORS OF YOUR PLANT?"
950 CLS:PRINT"WHAT FUEL DO YOU WANT TO POWER THE GENERATORS OF YOUR PLANT?"
960 CLS:PRINT"WHAT FUEL DO YOU WANT TO POWER THE GENERATORS OF YOUR PLANT?"
970 CLS:PRINT"WHAT FUEL DO YOU WANT TO POWER THE GENERATORS OF YOUR PLANT?"
980 CLS:PRINT"WHAT FUEL DO YOU WANT TO POWER THE GENERATORS OF YOUR PLANT?"
990 CLS:PRINT"WHAT FUEL DO YOU WANT TO POWER THE GENERATORS OF YOUR PLANT?"

```

WHAT FUEL DO YOU WANT TO POWER THE GENERATORS OF YOUR PLANT? 4

FINANCES OF BEGINNING OF YEAR	1	=====
GENERATING PLANTS OWNED		1
NUMBER OF CUSTOMERS		790
TONS OF COAL IN STOCK	1,600	
BARRELS OF FUEL OIL IN STOCK	2,500	
CASH RESERVE	\$1,000,000 00	
PEOPLE PROMISE TO CONSERVE	DEMAND WILL NOT RISE AS SHARPLY	
THIS YEAR.		

686.699 KILOWATTS ARE NEEDED. YOU HAVE 1 PLANTS
HOW MANY KILOWATTS FROM PLANT 1 600000
PLANT 1 NEEDS 1167 TONS OF COAL

YOU DID NOT GENERATE ENOUGH TO MEET DEMANDS.
 \$ 2268.77 DOLLARS WORTH OF DAMAGE HAS BEEN CAUSED TO THE
 EQUIPMENT. FORTUNATELY THIS WAS NOT A FATAL MISTAKE.

FUEL REQUIREMENTS		
1167 TONS OF COAL		
8 BARRELS OF FUEL OIL		
COST PER TON OR BARREL	SHIPPING	TOTAL COST
COAL \$22.20	\$3.77	\$25.97
FUEL OIL \$27.75	\$1.77	\$29.52

HOW MANY TONS OF COAL DO YOU WISH TO BUY?	1500
HOW MANY BARRELS OF FUEL OIL DO YOU WISH TO BUY?	200

COSTS	COAL	FUEL OIL	TOTAL
	\$30,955.00	\$5,904.00	\$44,859.00

REMODELING DOES NOT INCREASE THE GENERATING CAPACITY OF A PLANT. IT WILL RESTORE ALL PLANTS TO PEAK EFFICIENCY. ALL PLANTS MUST BE DONE AT THE SAME TIME.

PLANT	COST	INCREASE IN EFFICIENCY
1	\$5,716.58	2.91262 %
TOTAL COST	\$5,716.58	
DO YOU WISH TO REMODEL? 1=YES 2=NO 2		

COAL GENERATING PLANT WILL COST \$53,174.60
A FUEL OIL GENERATING PLANT WILL COST \$35,217.00
DO YOU WISH TO BUILD A NEW PLANT? 1=COAL 2=FUEL OIL 3=NEITHER 2

DO YOU WISH TO APPLY FOR A RATE INCREASE? 1=YES 2=NO 3=

IT HAS BEEN 8 YEARS SINCE YOU HAD A RAISE.
CUSTOMERS ARE PRESENTLY PAYING .05 PER KILOWATT
HOW MUCH DO YOU WISH TO CHARGE PER KILOWATT? .06
THE RATE INCREASE YOU REQUESTED HAS BEEN DENIED.
NO INCREASE IS ALLOWED

```

***** END OF YEAR 1 REPORT *****
INCOME FROM SALE OF POWER                                $34,000.00
MAINTENANCE COSTS                                         $13,320.00
YOU ARE GENERATING AT 60 % OF CAPACITY
THE INFLATION RATE FOR THE YEAR WAS                      11 %
THE CONSUMER PRICE INDEX NOW STANDS AT                  1.11

```

***** FINANCES FOR BEGINNING OF YEAR 2 *****	
GENERATING PLANTS OWNED	2
NUMBER OF CUSTOMERS	763
TONS OF COAL IN STOCK	1,933
BARRELS OF FUEL OIL IN STOCK	2,788
CASH RESERVE	\$940,604.00

888,888 KILOWATTS ARE NEEDED. YOU HAVE 2 PLANTS
HOW MANY KILOWATTS FROM PLANT 1 750000
PLANT 1 NEEDS 1391 TONS OF COAL.

50,000 KILOWATTS ARE NEEDED. YOU HAVE 2 PLANTS.
HOW MANY KILOWATTS FROM PLANT 2 50000
PLANT 2 NEEDS 151 BARRELS OF OIL.

FUEL REQUIREMENTS	
1391 TONS OF COAL	
151 BARRELS OF FUEL OIL	
COST PER TON OR BARREL	SHIPPING TOTAL COST

	COAL	FUEL OIL	STIFFING	TOTAL COST
	\$23.75		\$3.00	\$26.8
	\$29.69		\$2.01	\$31.7
HOW MANY TONS OF COAL DO YOU WISH TO BUY?	1500			

HOW MANY BARRELS OF FUEL OIL DO YOU WISH TO BUY? 300

L COSTS	COAL	FUEL OIL	TOTAL
---------	------	----------	-------

	\$40,245.00	\$9,510.00	\$49,755.00
REMODELING DOES NOT INCREASE THE GENERATING CAPACITY OF			

PLANT	COST	INCREASE IN EFFICIENCY
1	25,000.00	10%
2	30,000.00	12%
3	35,000.00	15%
4	40,000.00	18%
5	45,000.00	20%
6	50,000.00	22%
7	55,000.00	25%
8	60,000.00	28%
9	65,000.00	30%
10	70,000.00	32%
11	75,000.00	35%
12	80,000.00	38%
13	85,000.00	40%
14	90,000.00	42%
15	95,000.00	45%
16	100,000.00	48%
17	105,000.00	50%
18	110,000.00	52%
19	115,000.00	55%
20	120,000.00	58%
21	125,000.00	60%
22	130,000.00	62%
23	135,000.00	65%
24	140,000.00	68%
25	145,000.00	70%
26	150,000.00	72%
27	155,000.00	75%
28	160,000.00	78%
29	165,000.00	80%
30	170,000.00	82%
31	175,000.00	85%
32	180,000.00	88%
33	185,000.00	90%
34	190,000.00	92%
35	195,000.00	95%
36	200,000.00	98%
37	205,000.00	100%
38	210,000.00	102%
39	215,000.00	105%
40	220,000.00	108%
41	225,000.00	110%
42	230,000.00	112%
43	235,000.00	115%
44	240,000.00	118%
45	245,000.00	120%
46	250,000.00	122%
47	255,000.00	125%
48	260,000.00	128%
49	265,000.00	130%
50	270,000.00	132%
51	275,000.00	135%
52	280,000.00	138%
53	285,000.00	140%
54	290,000.00	142%
55	295,000.00	145%
56	300,000.00	148%
57	305,000.00	150%
58	310,000.00	152%
59	315,000.00	155%
60	320,000.00	158%
61	325,000.00	160%
62	330,000.00	162%
63	335,000.00	165%
64	340,000.00	168%
65	345,000.00	170%
66	350,000.00	172%
67	355,000.00	175%
68	360,000.00	178%
69	365,000.00	180%
70	370,000.00	182%
71	375,000.00	185%
72	380,000.00	188%
73	385,000.00	190%
74	390,000.00	192%
75	395,000.00	195%
76	400,000.00	198%
77	405,000.00	200%
78	410,000.00	202%
79	415,000.00	205%
80	420,000.00	208%
81	425,000.00	210%
82	430,000.00	212%
83	435,000.00	215%
84	440,000.00	218%
85	445,000.00	220%
86	450,000.00	222%
87	455,000.00	225%
88	460,000.00	228%
89	465,000.00	230%
90	470,000.00	232%
91	475,000.00	235%
92	480,000.00	238%
93	485,000.00	240%
94	490,000.00	242%
95	495,000.00	245%
96	500,000.00	248%
97	505,000.00	250%
98	510,000.00	252%
99	515,000.00	255%
100	520,000.00	258%

1	\$6,605.99	10.10
2	\$6,176.04	3.046
TOTAL COST		\$12,782.00
DO YOU WISH TO REMOVE? 1=YES 2=NO 3		

DO YOU WISH TO REMODEL? 1=YES 2=NO 2

GENERATING PLANT WILL COST \$58,685.40

A FUEL OIL GENERATING PLANT WILL COST \$79,829.00

DO YOU WISH TO APPLY FOR A RATE INCREASE? 1=YES 2=NO

***** END OF YEAR 2 REPORT *****
INCOME FROM SALE OF POWER \$40,400.00

MAINTENANCE COSTS \$20,939.20
YOU ARE GENERATING AT 40.4 % OF CAPACITY
THE INFLATION RATE FOR THE YEAR WAS 7.00001 %
THE COMBINED PRICE INDEX FOR 1980-1981 WAS 1.07001

[illegible]

***** FINANCES FOR BEGINNING OF YEAR 3 *****
GENERATING PLANTS OWNED 3

NUMBER OF CUSTOMERS	800
TONS OF COAL IN STOCK	2,042
BARRELS OF FUEL OIL IN STOCK	2,049

CASH RESERVE \$071,230.90
PEOPLE PROMISE TO CONSERVE. DEMAND WILL NOT RISE AS SHARP
THIS YEAR

813,599 KILOWATTS ARE NEEDED. YOU HAVE 3 PLANTS.
HOW MANY KILOWATTS FROM PLANT 1 800000
PLANT 1 NEEDS 1552 TONS OF COAL

12,599 KILOWATTS ARE NEEDED. YOU HAVE 3 PLANTS.
HOW MANY KILOWATTS FROM PLANT 2, 17599

8 KILOWATTS ARE NEEDED. YOU HAVE 2 PLANTS.

HOW MANY KILOWATTS FROM PLANT 3 @
PLANT 3 NEEDS 0 BARRELS OF OIL.
FUEL REQUIREMENTS

COST PER TON OR BARREL	SHIPPING	TOTAL COST
1557 TONS OF COAL		
36 BARRELS OF FUEL OIL		

COAL	\$26.36	\$3.16	\$29.52
FUEL OIL	\$32.95	\$2.58	\$35.45

HOW MANY TONS OF COAL DO YOU WISH TO BUY? 1200

HOW MANY BARRELS OF FUEL OIL DO YOU WISH TO BUY? 200

FUEL COSTS	COAL	FUEL OIL	TOTAL
	\$35,424.00	\$10,635.00	\$46,059.00

REMODELING DOES NOT INCREASE THE GENERATING CAPACITY OF A PLANT. IT WILL RESTORE ALL PLANTS TO PEAK EFFICIENCY. A

PLANT	COST	INCREASE IN EFFIC
1	\$7,699.20	14.38%

2	\$7,061.87	6.6467
3	\$6,987.24	5.6683
TOTAL COST	\$21,747.60	

CORAL GENERATING PLANT WILL COST \$62,720.00
A FUEL OIL GENERATING PLANT WILL COST \$48,719.00
DO YOU WISH TO BUILD A NEW PLANT? 1=CORAL 2=FUEL OIL 3=NEITHER 3

DO YOU WISH TO APPLY FOR A RATE INCREASE? 1=YES 2=NO 1
IT HAS BEEN 2 YEARS SINCE YOU HAD A RAISE
CUSTOMERS ARE PRESENTLY PAYING .05 PER KILOWATT
HOW MUCH DO YOU WISH TO CHARGE PER KILOWATT? .06
YOUR RATE INCREASE HAS BEEN STUDIED AND ACCEPTED AS REQUESTED

***** END OF YEAR 3 REPORT *****
INCOME FROM SALE OF POWER \$48,679.95
MAINTENANCE COSTS \$30,427.50
YOU ARE GENERATING AT 27.12 % OF CAPACITY
THE INFLATION RATE FOR THE YEAR WAS 11 %
THE CONSUMER PRICE INDEX NOW STANDS AT 1.21825

***** FINANCES FOR BEGINNING OF YEAR 4 *****
GENERATING PLANTS OWNED 3
NUMBER OF CUSTOMERS 904
TONS OF CORAL IN STOCK 1.685
BARRELS OF FUEL OIL IN STOCK 3.153
CASH RESERVE \$813,676.98

976,000 KILOWATTS ARE NEEDED. YOU HAVE 3 PLANTS.
HOW MANY KILOWATTS FROM PLANT 1 900000
PLANT 1 NEEDS 1650 TONS OF CORAL

76,000 KILOWATTS ARE NEEDED. YOU HAVE 3 PLANTS.
HOW MANY KILOWATTS FROM PLANT 2 50000
PLANT 2 NEEDS 136 BARRELS OF OIL

26,000 KILOWATTS ARE NEEDED. YOU HAVE 3 PLANTS.
HOW MANY KILOWATTS FROM PLANT 3 26000
PLANT 3 NEEDS 68 BARRELS OF OIL

FUEL REQUIREMENTS
1650 TONS OF CORAL
284 BARRELS OF FUEL OIL
COST PER TON OR BARREL SHIPPING TOTAL COST
CORAL \$27.42 \$5.09 \$33.31
FUEL OIL \$34.27 \$2.68 \$36.97

HOW MANY TONS OF CORAL DO YOU WISH TO BUY? 1000
HOW MANY BARRELS OF FUEL OIL DO YOU WISH TO BUY? 500
FUEL COSTS CORAL FUEL OIL TOTAL
\$33,318.00 \$18,435.00 \$51,753.00

REMODELING DOES NOT INCREASE THE GENERATING CAPACITY OF A PLANT. IT WILL RESTORE ALL PLANTS TO PEAK EFFICIENCY. ALL PLANTS MUST BE DONE AT THE SAME TIME.

PLANT COST INCREASE IN EFFICIENCY
1 \$7,548.54 9.09091 %
2 \$7,472.39 8.25688 %
3 \$7,129.62 3.04615 %
TOTAL COST \$22,142.00
DO YOU WISH TO REMODEL? 1=YES 2=NO 2

AL GENERATING PLANT WILL COST \$68,067.30
A FUEL OIL GENERATING PLANT WILL COST \$41,763.10
DO YOU WISH TO BUILD A NEW PLANT? 1=CORAL 2=FUEL OIL 3=NEITHER 3

DO YOU WISH TO APPLY FOR A RATE INCREASE? 1=YES 2=NO 2

***** END OF YEAR 4 REPORT *****
INCOME FROM SALE OF POWER \$50,560.00
MAINTENANCE COSTS \$32,960.00
YOU ARE GENERATING AT 32.5333 % OF CAPACITY
THE INFLATION RATE FOR THE YEAR WAS 4 %
THE CONSUMER PRICE INDEX NOW STANDS AT 1.37100

***** FINANCES FOR BEGINNING OF YEAR 5 *****
GENERATING PLANTS OWNED 3
NUMBER OF CUSTOMERS 976
TONS OF CORAL IN STOCK 1.835
BARRELS OF FUEL OIL IN STOCK 3.489
CASH RESERVE \$787,531.12

1,054,000 KILOWATTS ARE NEEDED. YOU HAVE 3 PLANTS.
HOW MANY KILOWATTS FROM PLANT 1 900000
YOU DO NOT HAVE ENOUGH CORAL.
YOU HAVE MISMANAGED YOUR FUEL INVENTORY. THAT IS TOO BAD, FOR YOU WERE DOING FINE IN OTHER AREAS OF MANAGEMENT. BUT THE BOARD OF DIRECTORS WERE UNSYMPATHETIC. YOU WERE CRYING.

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I'd rather be playing spacewar — black with white spaceships and lettering.

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Creative Computing — Albert Einstein in black on a red denim-look shirt with red neckband and cuffs.

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creative computing

Building a Mouse

Jerry W. Lee



Does The Name Pavlov Ring A Bell?

The theory of learning has been central to experimental psychology since Pavlov's dogged experiments over fifty years ago. Some theorists (like Hull and, more recently, Skinner) think learning theory covers all behavior, and that such areas of psychology as perception, personality and human motivation can eventually be predicted and controlled within its framework.

To the learning theorist, every organism is always in a "learning" situation but starkly simplified learning experiments, like running mice through mazes are seen as the clearest way to experiment in this field. Learning takes place when reward (or "reinforcement") occurs; under reinforcement, the organism becomes more likely to emit a certain "behavior." Punishment, or negative reinforcement, doesn't work as well.

Enough said. Here's a simplified mouse you can train all you like. But be aware that while you are training it, it is training you. —TN

simulate a mouse would have to be far more limited in its repertoire of possible behavior.

I decided that the mouse simulated would be a very simple one. It would only engage in nine "behaviors." The mouse would be represented by an M on a CRT screen — graphics terminals were not available at the time — and would be able to move up or down, right or left, or on any of the four diagonals. The ninth behavior would be remaining in the same place. This, then, was the original conception of the mouse. As programming continued, other elements were added to the original conception until the current version was developed.

Most people would be happy to get rid of mice. Our problem was a lack of them — or rather the space, supplies, and time necessary to raise them for use in an introductory psychology class. One of the most effective ways of teaching students the basic principles of learning is to give them actual "hands on" experience in training an animal. Mice, or more frequently rats, are used for this purpose because they take up little space, are relatively easy to raise, and learn relatively rapidly. Nevertheless, when one has four or five hundred students a year taking Introductory psychology, the cost of raising and caring for enough mice or rats for all of these students is prohibitive. It is a rare psychology department that can afford such an expensive learning aid.

Computers, on the other hand, do not have to be fed or cleaned up after, and can easily be taught. While their

Initial cost is high, their upkeep is low (compared to that of a rat colony), and they can do many other things besides run mazes or push bars in a Skinner box.

For these reasons I decided to attempt to develop a computer program to simulate a mouse which could then be trained by students using our PDP 11/40, under the RSTS-E time sharing system. The program would be written in DEC Basic -PLUS. I decided to call the simulation a mouse simulation rather than a rat simulation simply because mice have received much better press than rats.

The "brain" of a computer is well understood. It has to be, since humans manufacture it. But the brain of a mouse is quite complex, in comparison to a digital computer, and is not at all well understood. No one so far has succeeded in developing a computer program that can simulate all the behavior of a mouse. Any computer program which was developed to

To reinforce the student's behavior, a word such as "YUM," "MMM!", or "SLURP" briefly appears on the screen in the place of the mouse whenever the student reinforces the mouse.

In any training situation there must be a goal or a series of sub-goals. For our mouse, the goal is to receive reinforcement and/or avoid punishment. For our students, the goal is to give the mouse a series of reinforcements and/or punishments until the mouse learns to move to the left and reaches a goal represented by a row of G's along the left side of a CRT screen.

Jerry W. Lee, Department of Psychology, Loma Linda University, Riverside, CA 92515.

For your Apple II....

MUSIC

&

GRAPHICS

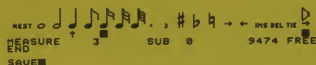
ALF Music Synthesizer

The ALF music synthesizer has three voices on each board which are easily programmed using the Entry program provided. The envelope shape of each voice (or even each note) may be controlled individually thus allowing the synthesis of practically any instrument such as a violin, trumpet, piano, harp or bells. Instrumentation and dynamics may be varied while a song is playing by changing the attack, sustain, release, decay, gap and volume of the notes.

Playback of music is accompanied by a spectacular color display showing a stylized "piano keyboard" for each part with the colors of the notes varying in proportion to their loudness and waveform.

Ease of Music Entry

Music is entered directly using the high-resolution graphics entry program. One paddle is used to select menu items such as note duration, accidentals, dotted notes, triplets, tied notes, etc. while the other paddle moves a note cursor up and down the staff over a 4-octave range. The transpose command extends the range to eight octaves. This form of music entry is considerably faster and more accurate than cryptic note code schemes (like QFS3) found with other synthesizers.



MUSIC ENTRY SCREEN

Advanced Features

The Entry program also permits easy editing of previously-entered music including insert, delete and change. New parts may be added (up to nine—3 parts per board). "Subroutines" can be used for repeated parts, codas, and fugues.

The board plugs into any Apple II or Apple II Plus. Two or three boards are required for stereo. Requires a 16K Apple system and external amplifier and speakers.

"Phil Tubbs' ALF music board sets high standards in ease of music entry, stereo output and overall flexibility."

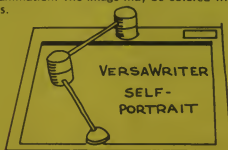
Creative Computing Magazine,
June 1979

Six music disks will be available in June.

VersaWriter

VersaWriter is a drawing tablet for the creation of full-color, high resolution graphic images on the Apple. Images may be drawn freehand or traced from existing images (cartoons, photos, drawings, etc.) using the simple pivoted two-arm pantograph with magnifying crosshairs.

After an image is drawn, it may be rotated, shrunk, or enlarged. It may be moved across the screen and alternated with other images thus providing high-resolution animation. The image may be colored with varied colors.



Animate other Programs

Graphical images made with VersaWriter and stored on tape or disk may be called from other programs or even imbedded in them. With VersaWriter, you don't have to worry about assembly code, counting pixels or other cumbersome hi-res graphics entry and retrieval techniques.

VersaWriter graphics can be used in all types of programs—games, statistics, engineering, artistic, and educational. Your only limit is your own imagination.

Two Disks of Software

Disk 1 contains the basic plotting, scaling, movement, rotation, color, transfer and recall software. This disk also includes routines which create "shape tables" from your figures to be used in other programs. Disk 2 contains applications software. One program adds five sizes of upper and lower case text to drawings, another adds standard electronic and digital symbols, while a third calculates distances and areas.

VersaWriter requires a 32 or 48K disk system, Applesoft in ROM or an Apple II Plus.

VersaWriter \$252.00

ALF Music Synthesizer \$268.00

ALF/Applesoft Software 15.00

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Mouse, cont'd...

Several constraints were placed on the mouse's behavior. First, the mouse had to react visibly when reinforced or punished by the student. This was necessary in order to reinforce the student's behavior. The visible reaction is accomplished by having a word such as "YUM," "MMMI," or "SLURP" briefly appear on the screen in the place of the mouse whenever the student reinforces the mouse. Words such as "UGH," "OUCH," and "SCREECH" appear when the student punishes the mouse. The student delivers reinforcement to the mouse by pushing the return key

As noted earlier, MOUSE is a rather limited mouse. It will behave like a real mouse only when reinforcement occurs for every correct behavior (continuous ratio reinforcement) or punishment occurs for every incorrect behavior.

on the keyboard. A punishment is delivered whenever the student presses the space bar.

A second constraint on the mouse's behavior was that it had to become more eager to behave when being reinforced, and less eager when being punished. The point of this was to teach students the difficulty of using punishment to train animals to do something rather than *not* do something. The problem is that in using punishment to train someone to do something, you must punish all behaviors except the correct behavior. In the process an organism may become reluctant to behave at all, because behavior frequently results in punishment.

A third constraint on the mouse was that the mouse shall have a comparatively short short-term memory. One of the clearest findings in the learning literature is that the sooner reinforcement for punishment occurs after a behavior is emitted the more quickly the behavior is learned. Thus our mouse was constructed so that if a student did not reinforce or punish the mouse promptly (within one second) when it behaves, the behavior reinforced or punished is sitting in one place. Thus, delays in reinforcement result in the mouse learning to sit still. Delays in punishment result in the mouse learning to move, but learning

to move in a random manner.

The Learning Algorithm

Since this mouse was to be a simple one, a simple learning algorithm was devised. A simplified version of the overall algorithm is presented in Figure 1 and Figure 2. (Since this flowchart is intended to clarify the method by which the mouse learns, it does not include the routines that implement the first and second constraints discussed above, or the provision for a "smart" or "dumb" mouse, or the end routine.) For information about these routines you may consult the program itself, which accompanies this article.

The mouse's learning is handled in the following way: A set of sixty memory locations in the computer are randomly assigned the numbers one through nine. These numbers represent the mouse's nine possible behaviors. The computer randomly selects one of the sixty memory locations. If the behavior represented by the mouse does not move the mouse off the CRT screen, then the computer mouse engages in the indicated behavior. If the mouse reaches the goal the training trial is terminated. If reinforcement occurs within one second, the mouse enters the reinforcement subroutine. If punishment occurs, the mouse enters the punishment subroutine. These subroutines will be discussed later. If reinforcement occurs after one second has elapsed, but prior to the expiration of a short wait before the next behavior, the reinforcement subroutine is entered — but the behavior reinforced is "sitting in the same place." If punishment occurs after one second has elapsed, but prior to the expiration of a short wait before the next behavior, then the punishment subroutine is entered — but the behavior punished is "sitting in the same place." If no reinforcement or punishment occurs prior to the expiration of the second wait, then the extinction subroutine is entered. Entry into the punishment or reinforcement subroutine causes the program to enter another wait of variable length (W1% seconds). If reinforcement or punishment occurs during this wait, the behavior reinforced or punished is "sitting," and the wait begins again. If no reinforcement or punishment occurs, then a new memory location from the sixty-element array is selected and the sequence begins again. This last wait, and the reinforcement or punishment of sitting, are necessary to prevent over-eager students from speeding up the mouse by simply terminating each random wait period by delivering reinforcers or punishers.

It may be helpful, at this point, to explain the concept of a wait. WAIT is a statement in DEC Basic-PLUS which causes the computer to wait for input a specified number of seconds. If no input occurs before the specified number of seconds expires, then a trappable error occurs. An error subroutine can then be used to tell the computer what to do in that case.

The reinforcement subroutine. The steps that take place when this subroutine is entered are as follows. The sixty-element memory array is searched n times. The value for n depends on the smartness-level of the mouse selected by the students. The object of each search is to find numbers representing behaviors which are *not* similar to or identical with the behavior just engaged in.

If reinforcement occurs after one second has elapsed, the reinforcement subroutine is entered — but the behavior reinforced is "sitting in the same place."

Suppose that the mouse had been reinforced for moving directly to the left. Movements diagonally upward and to the left or diagonally downward and to the left would be similar to the reinforced behavior. Once the routine finds a number representing a behavior *not* similar to the direction that has just been reinforced, then this number is replaced with the number representing the reinforced behavior. Thus the sixty-element array becomes increasingly loaded with behaviors similar to those which have been reinforced. Since behaviors similar to the reinforced behavior are not replaced by this method, the result also weights the array to simulate some generalization of response. The program then enters the wait-state described earlier.

In addition, the maximum wait of the mouse before the next behavior occurs is decreased if the minimum wait has not been reached. This causes the mouse to appear more "eager" to behave.

The punishment subroutine. The action of the punishment subroutine is very similar to the action of the reinforcement routine. The computer makes n searches through the sixty-element array until a number representing a behavior identical with the behavior punished is found. This number is then replaced with a number which is *not* similar to or identical with

Mouse, cont'd...

the number representing the behavior punished. If the maximum wait has not already been reached, the mouse's wait before the next behavior is also increased, so that the mouse appears more "reluctant" to behave.

The extinction subroutine. The extinction subroutine is very simple in action. A number between one and nine (representing one of the nine behaviors) is randomly selected and this number is inserted into the memory location which held the most recent behavior engaged in by the mouse. If no reinforcement or punishment occurs for a number of trials, the mouse will gradually "forget" what it has learned.

Use of the Program

The mouse is usually used as an outside assignment for students. Since the program will run in a time-sharing environment, many students can run the program simultaneously. Students are given a handout describing how to operate the computer to run the mouse simulation. They are then asked to train several mice with punishment, several with reward, and to record the amounts of time, and numbers of trials, reinforcements, and punishments

needed to train each mouse. They are then asked to read the text material on learning, to describe the differences they found under conditions of reinforcement and punishment, and to discuss why these differences exist and what sort of learning is actually occurring.

As in real life, the performance of the mouse is almost invariably worse with punishment than with reward.

As in real life, the performance of the mouse is almost invariably worse with punishment than with reward. The three most common (correct) reasons that students give for this fact are:

1. Punishing the mouse's movement in the wrong direction also punishes movement in general so the mouse becomes less willing to move.

2. Students tend only to punish behaviors which move the mouse away from the goal; irrelevant movements, such as moving up or down, are not punished. Thus it takes longer for the mouse to learn with punishment because it engages in more irrelevant behavior.

3. When the mouse is moving toward the goal nothing happens to it. Thus, the mouse will gradually forget what it has learned. Extinction sets in.

Students generally report that they find the computer experience enjoyable. MOUSE has been in use for approximately 18 months and is believed to be relatively bug-free.

Limitations

As noted earlier, MOUSE is a rather limited mouse. It will behave like a real mouse only when reinforcement occurs for every correct behavior (continuous ratio reinforcement) or punishment occurs for every incorrect behavior. If more complex reinforcement is attempted — for example, reinforcing every third correct behavior (fixed ratio three), then MOUSE's behavior will not duplicate that of a real mouse. In addition, MOUSE's learning curve for continuous-ratio reinforcement does not exactly duplicate that of a real mouse. These problems are being worked on and a possible solution is being attempted. Nevertheless, the current version of MOUSE does serve a useful function in the general psychology lab, in causing students to think about the differences between reinforcement and punishment. □

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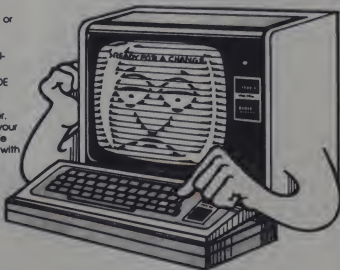
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5 1
1  \ MOUSE -- A SIMULATION
1  \
1  \ FOR GENERAL PSYCHOLOGY
1  \
1  \ COPYRIGHT 1979 BY JERRY M. LEE
10 RANDOMIZE
15 ON ERROR GO TO 810
20 DIM M$(615),R$(615),P$(615),B$(615)
1  \ M$( ) = MOUSE'S MEMORY.
1  \ P$( ) = REINFORCEMENT WORDS.
1  \ R$( ) = BEHAVIORS IN THE FORM OF CURSOR MOVEMENT COMMANDS.
1  \ B$( ) = BEHAVIORS IN THE FORM OF CURSOR MOVEMENT COMMANDS.
30 DATA "OUCH","UGH","EEEK!","SCREECH","EAG$E$!"
50 READ P$(15) FOR I=15 TO 65
60 DEF FN R$(X)=RND(0)+.15
1  \ RANDOM NUMBER REPRESENTING ONE OF NINE BEHAVIORS.
64
1  \ P$1 = R$
1  \ M$1 = R$
1  \ N$1 = 60%
1  \ W$1 = 80%
1  \ V$1 = 15%
1  \ M$1 = 5%
1  \ REINFORCEMENT SMARTNESS (LARGER NUMBER MAKES SMARTER).
1  \ PUNISHMENT SMARTNESS.
1  \ REINFORCEMENT AND PUNISHMENT MAKE CURSOR MOVE (IN SEC.).
1  \ SIZE OF MOUSE'S MEMORY.
1  \ WIDTH OF CRT SCREEN IN CHARACTERS.
1  \ NUMBER OF LINES ON CRT SCREEN
1  \ AMOUNT TO WAIT FOR REINF. OR PUNISH. BEFORE TRANSFERRING TO
1  \ NEXT LINE.
1  \ SIZE OF LEFT OR RIGHT MOVE.
66
1  \ P$1=2% IF R2K<2%
1  \ P$1=2% IF P2K<2%
80 DEF FN R2$(X)=RND(0)+.15
1  \ OBTAINS RANDOM NUMBER TO SELECT MEMORY LOCATION IN M$( ).
90 DATA "SHACK","YOMI","CHOMP","BURP!","MRR!!","SLURP"
110 READ R$(1) FOR I=1 TO 6
120 PRINT CHR$(155*H)+CHR$(155)*J
1  \ HOME AND CLEAR SCREEN.

```

```

130 PRINT THIS PROGRAM IS DESIGNED TO SIMULATE:
1  \ PRINT THE OPERANT CONDITIONING OF A MOUSE.
1  \ PRINT THE OBJECT IS TO GET THE MOUSE TO:
1  \ PRINT GO TO THE GOAL BY REINFORCING THE CORRECT
135 PRINT RESPONSES AND/OR PUNISHING INCORRECT RESPONSES.
1  \ PRINT THE MOUSE IS REPRESENTED BY
1  \ PRINT THE LETTER M. THE GOAL IS REPRESENTED BY A LINE OF G'S.
140 PRINT TO REINFORCE THE MOUSE PUSH THE RETURN:
1  \ PRINT KEY WITHIN ONE SECOND AFTER HE MOVES:
1  \ PRINT TO PUNISH HIM PUSH THE SPACE BAR. IF YOU TAKE LONGER:
1  \ PRINT " THAN A SECOND YOU MAY"
145 PRINT CONFUSE THE MOUSE.
150
1  \ L$=CHR$(65)
1  \ R$=CHR$(155)*J+C
1  \ D$=CHR$(155)*J+A
1  \ D$=CHR$(155)*J+A
1  \ B$=CHR$(13)
1  \ B$=CHR$(13)
1  \ H$=CHR$(155)*J+H
1  \ C$=CHR$(155)*J+J
1  \ S$=CHR$(155)*J+S
1  \ S$=CURSOR CONTROL FUNCTIONS **
1  \ L$ = LEFT.
1  \ R$ = RIGHT.
1  \ U$ = UP.
1  \ D$ = DOWN.
1  \ H$ = HOME.
1  \ C$ = CLEAR TO END OF SCREEN.
1  \ E$ = ERASE TO END OF LINE.
210
1  \ S$=L$+R$+U$+D$+H$+C$+E$
1  \ IF PRINTED ERASES MOUSE AND PLACES CURSOR IN MOUSE'S FORMER
1  \ POSITION.
230
1  \ B$(45)=S$
1  \ B$(55)=S$
240
1  \ FOR I=15 TO M31
1  \ B$(45)=B$(45)+R1
1  \ B$(55)=B$(55)+L1
1  \ NEXT I
1  \ LOOP PUTS IN RIGHT ON LEFT COMPONENT OF BEHAVIOR.
250
1  \ B$(15)=B$(45)+U5
1  \ B$(55)=S$+U5
1  \ B$(55)=B$(45)+U5
1  \ B$(55)=B$(45)+D5
1  \ B$(55)=B$(45)+D5
1  \ B$(55)=B$(45)+D5
1  \ B$(55)=S$+S$+S$+S$+S$
1  \ B$(55)=B$(97)*J
1  \ INSTALL BEHAVIORS.
1  \ I = LEFT & UP.

```

```

1 2 = UP.
1 3 = RIGHT & UP.
1 4 = RIGHT.
1 5 = RIGHT & DOWN.
1 6 = DOWN.
1 7 = LEFT & DOWN.
1 8 = LEFT.
1 9 = REMAIN IN SAME PLACE.
320 OPEN #KB: " AS FILE 15
330 MS(15)=FNR15 FOR IS=15 TO M15
    \ M15=(M15-15)/25+05
    \ RANDOMIZE MOUSE'S MEMORY
    \ SET VALUE OF STANDARD WAIT TO HALF MAXIMUM.
340 PRINT
    \ INPUT "DO YOU WANT A SMART MOUSE OR A DUMB MOUSE?";$
    IF $#="S" THEN S95=-15
    \ GO TO 390
    I S95 = SMART FLAG = -1 FOR SMART MOUSE = 0 OTHERWISE.
370 IF $#="D" THEN S95=05
    \ GO TO 390
380 PRINT "TYPE AN S OR A D PLEASE."
    \ GO TO 350
390 PRINT
    \ M5 = 05
    \ S5 = 05
    \ P15 = 05
    \ P15 = P15 - PUSH THE RETURN BUTTON TO START THE GAME";05
    I PRINT A LINE.
    I ZERO MOVE COUNTER.
    I ZERO REINFORCEMENT COUNTER.
    I ZERO PUNISHMENT COUNTER.
    I START GAME.
400 PRINT H5+C5
    I HOME & CLEAR.
410 I
    BEGIN SIMULATION
430 PRINT "G" FOR IS=15 UNTIL IS>G5-15
    I PRINT GOAL.
450 DIS=" "
    \ DIS=DIS+D5 FOR IS=15 TO G5/25
    \ PRINT H5:DIS;"G";TAB(95);
    I MOVE CURSOR TO APPROX. MIDDLE OF SCREEN.
460 S5=SYS(CH$$(35))
    I TURN OFF TERMINAL ECHOING.
470 PRINT "LET'S START. HERE'S THE MOUSE."
    I STARTING SIGN.
480 SLEEP 35
490 PRINT "H5:G5:R5:55:
    I ENDS-STARTING SIGN.
500 PRINT B5:
    \ PRINT H5:TAB(60);
    I MOVE CURSOR TO MOUSE'S STARTING POSITION.
520 T1=TIME(05)
    \ H5=605
    \ V5=C5/25+15
    \ S5=C5/25+15
    I H5 = HORIZONTAL POSITION.
    I V5 = VERTICAL POSITION.
540 PRINT "M":
    GOSUB 1300
550 I SIT FOR AMHILE BEFORE BEHAVING.
555 R5=FNR25
    \ R5=(R5-25)/25+05
    \ R15=05
    I SELECT BEHAVIOR TO TEST
    I THEN ZERO RESPONSE FLAG (55)
570 T15=0
    I ZERO ILLEGAL BEHAVIOR COUNTER.
590 T15=T15+15
    \ T15=T15+15 THEN M5(N*25)=FNR15
    \ M5=M5+N*25
    I IF MORE THAN TWENTY ILLEGAL BEHAVIORS ARE ATTEMPTED TAKE A
    RANDOM MOVE.
    I AN ILLEGAL BEHAVIOR ONE WHICH WOULD TAKE THE MOUSE OFF THE SCREEN
    ON M5 GO TO 610. 620. 630. 640. 650. 660. 670. 680. 720
    I CHECK FOR LEGALITY OF BEHAVIOR.
600 H15=M35
    \ V15=15
    \ GO TO 690
620 H15=05
    \ V15=15
    \ GO TO 690
630 H15=M35
    \ V15=15
    \ GO TO 690
640 H15=M35
    \ V15=05
    \ GO TO 690
650 H15=M35
    \ V15=15
    \ GO TO 690
660 H15=05
    \ V15=15
    \ GO TO 690
670 H15=M35
    \ V15=15
    \ GO TO 690
680 H15=M35
    \ V15=05
    \ GO TO 690

```



```

690 IF H$=H$13 GO TO H$6
    IF GOAL HAS BEEN REACHED GO TO END ROUTINE.

700 H$=H$+H$13
    \ V$=V$+V$13
    \ M$=M$+M$13
    GO TO 550
    IF SELECTED BEHAVIOR IS ILLEGAL (MOVES MOUSE OFF SCREEN) THEN
        SELECT A NEW BEHAVIOR AND GO TO THE BEGINNING OF
        THE NEXT ROUTINE.

710 H$=H$2
    \ V$=V$2
    \ M$=M$2
    RECORD NEW HORIZONTAL POSITION.
    RECORD NEW VERTICAL POSITION.
    COUNT MOVE.

720 PRINT B$(M$);"";
    MOUSE BEHAVES !!!

740 WAIT M$
    GIVE USER M$ SECONDS TO RESPOND TO MOVE.
    EXHAUSTED WAIT GOES TO ERROR ROUTINE WHICH RESUMES AT SIT ROUTINE.

770 S$=SYS(CHR$(45))
    S$=SYS(CHR$(45))
    SYS(CHR$(45)) = SET SINGLE CHARACTER GET MODE.
    SYS(CHR$(15)) = CLEAR KEYBOARD BUFFER.

780 FIELD #15, 105 AS #15
    GET #15.
    R15=LEFT(#15,15)
    GET USER'S RESPONSE.
    SET RESPONSE FLAG (#5) TO INDICATE A RESPONSE WAS MADE.

790 IF R15=CHR$(32) THEN GOSUB 1030 ELSE GOSUB 1150
    IF SPACEBAR HIT GO TO PURSUIT ROUTINE OTHERWISE GO TO
    REINFORCEMENT ROUTINE.

794 GOSUB 1300
    GO TO SIT SUBROUTINE.
    PROGRAM ALSO TRANSFERS TO THIS LINE WHEN WAIT EXHAUSTED ERROR
    OCCURS IN LINE 780.

796 GOSUB 817 IF NOT R15
    GO TO EXTINCTION ROUTINE IF NO RESPONSE FROM USER IN LINE 780.

800 GO TO 555
    RETURN TO SELECT ANOTHER BEHAVIOR.

805 I
    ERROR HANDLING ROUTINES

810 IF ERROR$ THEN ON ERROR GO TO 0
    IF ERROR IS NOT AN EXHAUSTED WAIT THEN TERMINATE PROGRAM.

811 IF ERL=780 THEN RESUME 794
    IF ERL DID NOT RESPOND TO BEHAVIOR WITHIN M$ SECONDS.

815 IF ERL=1320 THEN RESUME 1350
    IF USER DID NOT RESPOND DURING SIT PERIOD.

816 ON ERROR GO TO 0
    IF AN UNPLANNED ERROR HAS OCCURRED, TERMINATE THE PROGRAM.

817 I
    EXTINCTION ROUTINE

820 M$(N2)=FNRI$
    REPLACE LAST USED BEHAVIOR IN MEMORY WITH A RANDOM BEHAVIOR.

840 RETURN
    RETURN TO MAIN PROGRAM FOR RETURN
    BEHAVIORAL SELECTION ROUTINE.

850 I
    EXIT ROUTINE

860 S$=SYS(CHR$(25))
    ENABLE TERMINAL ECHOING

870 PRINT B$(M$);"";B$.
    \ V$=V$+V$15
    \ M$=M$+M$15
    MOVE TO GOAL!!!
    INCREMENT MOVEMENT COUNTER.

880 FOR I$=1 TO 85
    PRINT H$;
    FOR J$=1 TO G$-1$
        PRINT D$;"";L$;
    PRINT J$;
    START GOAL FLASHING LOOP
    BLANK OUT GOAL

920 PRINT H$;"";L$ TO G$-1$
    PRINT D$;"";L$;
    NEXT J$
    NEXT I$
    PRINT GOAL AGAIN
    PRINT "YOU HAVE USED M$ REINFORCEMENTS AND";
    PRINT P15; "PUNISHMENTS FOR THIS MOVE."

950 PRINT "THE MOUSE MADE IT TO THE GOAL IN";TIME(0$)-T1;"SECONDS."
    PRINT H$+C$+D$;TAB(20$);"CONGRATULATIONS"

960 PRINT "YOU HAVE USED M$ REINFORCEMENTS AND";
    PRINT P15; "PUNISHMENTS FOR THIS MOVE."

980 PRINT "THIS MOUSE HAS MOVED";M$;"TIMES."
    WAIT 0$
    CANCEL WAIT STATE.

1000 INPUT DO YOU WANT TO TRY AGAIN?"Q1
    IF LEFT(Q1,1$)=Y THEN PRINT
    YOU WANT TO USE YOUR OLD MOUSE (TYPE O) ";
    TRIM#Q1 DO YOU WANT TO TRY AGAIN?"Q2
    IF LEFT(Q2,1$)=N GO TO 340 ELSE GO TO 390
    IF LEFT(Q3,1$)=Y THEN PRINT"ANSWER YES OR NO PLEASE."
    GO TO 1000

1010 PRINT H$;C$
    HOME CURSOR AND CLEAR SCREEN.

```

[illegible]

COMM-80



HARDSIDE in conjunction with MICROMINT has solved the TRS-80 I/O bottle-neck. This new expansion interface, designed

by Steve Ciarcia, is described in detail in the June issue

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were a natural output from his equations.

A typical encounter with MACMAN is shown in Figures A to D. Figure A shows MACMAN's heart beating normally at 72 beats per minute (shown as symbol*), and maintaining an average blood pressure of 121/75 millimeters of Mercury (mmHg) — systolic/diastolic pressures, shown with symbols XXXXXX. This is the normal 'intact' subject which represents a relatively healthy young adult male at rest weighing about 70 Kg at rest. His total blood volume is 5 litres (about 9.2 pints), and this is approximately equal to the volume pumped through the heart every minute — the cardiac output. We now simulate the effect of a sudden loss of blood of about 2 litres (about 3.7 pints). MACMAN goes into an immediate state of shock (Figure B), and his blood pressure falls to about 40/21 mmHg. It is noted that the heart is not getting enough blood to the kidneys. Various protective reflexes are immediately invoked, including an increase in heart rate, and at the end of one minute you will notice that the heart rate has risen to 132 beats per minute! His blood pressure recovered slightly to a mean value of 50/34 mmHg. But all is not well. He is "not feeling too well" and "his eyes are going dim." If the simulation were allowed to continue for another three minutes, MAC-

We must first determine the laws governing a system and the intricate relationships between all the varying factors, before we can program them into a computer—this is a formidable task.

MAN would die and we would have a post-mortem report. The first task, therefore, is to elevate and stabilize his blood pressure. You would try an injection of noradrenalin to constrict his arteries (simulated in MACMAN by doubling the arterial resistance). Figure C shows the effect of this drug; his blood pressure has indeed gone up to 97/70 mmHg and his heart has slowed somewhat to 110 beats per minute. MACMAN is "feeling better but not right yet" — he has stabilized and his symptoms have improved. But

```

DO YOU WANT TO 1.CHANGE, 2.CONTINUE, 3.RESTART, 4.STOP THE MODEL
21
1.1.CHANGE FACTORS, 2.BARORECEPTOR FUNCTION, 3.DISPLAYS
71
TYPE THE NUMBERS OF FACTORS (1-5) TO BE CHANGED
75
FACTOR 5 (CURRENTLY= 5000.0 ), SPECIFY NEW VALUE
73000
DO YOU WANT TO 1.CHANGE, 2.CONTINUE, 3.RESTART, 4.STOP THE MODEL
72

```

```

TIME 0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300
SECS
4      XXXX
8      XXXXX
12     XXXX
16     XXXX
20     XXXXX
24     XXXXX
28     XXXX
32     XXXXX
36     XXXX
40     XXXX
44     XXXX
48     XXXX
52     XXXX
56     XXXX
60     XXXXX

```

I FEEL REALLY TERRIBLE

I FEEL AS IF I AM GOING TO DIE. MY EYES ARE GOING DARK.
WHAT IS HAPPENING TO ME?
YOUR PATIENT IS PASSING HARDLY ANY URINE

B.P. SYSTOLIC= 50 DIASTOLIC= 34 MEAN= 40.0
RIGHT ATRIAL PRESS.= -3.3 MM HG MEAN CAPILL.PRESS.= 3.9 MM HG
CARDIAC OUTPUT= 1.9 L/MIN. STROKE VOL.= 14.7 ML. HEART RATE= 132.
ART.RESIST.= 19.9 VENOUS RESIST.= 2.2 MM HG/L/MIN
CARDIAC CONTRACTILITY= 1.1 L/MIN/MM HG FILLING PRESS.
VALUES FOR THIS RUN WERE...

1. ART. RESISTANCE= 100.0 % OF NORMAL
2. VEN. RESISTANCE= 100.0 % OF NORMAL
3. CARDIAC CONTRACTILITY= 100.0 % OF NORMAL
4. MEAN INTRATHORACIC PRES.= -2.0 MM HG
5. BLOOD VOLUME= 3000.0 ML

Figure B MACMAN has suddenly lost 2 litres of blood. His blood pressure has fallen and his heart is beating very rapidly.

note that his blood volume is still at the reduced level of 3 litres and his heart is pumping only about 2.1 litres of blood per minute (cardiac output) — not enough to provide the body cells with the necessary nutrients to maintain a healthy state. However, we shall have mercy on the poor soul and relieve his agony by giving him a blood transfusion of 3 units or about 1.6 litres (and at the same time let the arteries return to their normal state). This is shown in Figure D — after an initial imbalance, the blood pressure and heart rate return to very nearly the normal values (shown in Figure A). The heart is pumping away at 4.6 litres per minute and MACMAN is tickled pink — he acknowledges your efforts and is wondering what nasty motives you have next! This example would have given you an idea of how MACMAN can oblige by letting you perform drastic experiments on him and is even willing to "die" many times for the sake of science! Hundreds of similar experiments can be performed by changing the five "factors" in different combinations. These factors are:

1. Arterial Resistance (expressed as percent of normal value) — is a measure of the pressure required to drive blood through the circulation channels in the body.

2. Venous Resistance (expressed as percent of normal value) — determines the return of blood to the heart.

3. Contractility (expressed as percent of normal value) describes the effectiveness of the heart as a pump.

4. Intra-thoracic pressure (mm of Mercury) is the pressure difference between the pressure inside the chest and the atmospheric pressure.

5. Blood volume is the total blood volume in the body in millilitres.

MACMAN proved to be a great success and was quickly included in the medical curriculum at McMaster University, and later at many other medical schools around the world. This was easy because, unlike many physiological simulations, the interface between the user and the model has been accorded as much attention as the model itself. So anyone who can type with one finger can tinker with MACMAN's physiology. It also led Dr. Dickinson, and his associates in Can-

Medical, cont'd . . .

ada and England, to explore the possibilities of simulating other aspects of human physiology. A flurry of activity has followed at McMaster University and St. Bartholomew's Hospital in London. Four new models have evolved. They are far more complex and versatile than MACMAN and have been named MACPUF (simulation of lungs and respiration), MACPEE (simulation of—you guessed it—kidneys and body fluids), MACBABE (simulation of respiration in a pre-mature baby), and finally a very elegant model MACDOPE (simulation of drug distribution in the body), developed by a medical student Ralph Bloch (who is now a Professor at McMaster).

These simulation models have added a new dimension to medical education and research. Not only have they saved many animal experiments

MY MEAN
INTRATHORACIC
PRESSURE IS
-2.0 MM HG
... AH HA!



DO YOU WANT TO 1.CHANGE, 2.CONTINUE, 3.RESTART, 4.STOP THE MODEL
?1

1.CHANGE FACTORS, 2.BARORECEPTOR FUNCTION, 3.DISPLAYS

?1
TYPE THE NUMBERS OF FACTORS (1-5) TO BE CHANGED

FACTOR 1 (CURRENTLY= 100.0), SPECIFY NEW VALUE
?200

DO YOU WANT TO 1.CHANGE, 2.CONTINUE, 3.RESTART, 4.STOP THE MODEL
?2

TIME SECS	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
64					XXXXXX											
68					XXXXXX											
72					XXXXXX											
76					XXXXXX											
80					XXXXXX											
84					XXXXXX											
88					XXXXXX											
92					XXXXXX											
96					XXXXXX											
100					XXXXXX											
104					XXXXXX											
108					XXXXXX											
112					XXXXXX											
116					XXXXXX											
120					XXXXXX											

I AM VERY TIRED AND EXHAUSTED

I DON'T FEEL LIKE DOING ANYTHING

I FEEL BETTER BUT NOT RIGHT YET.

CAN'T YOU DO SOMETHING FOR ME ?

YOUR PATIENT IS PASSING HARDLY ANY URINE

B.P. SYSTOLIC= 97 DIASTOLIC= 70 MEAN= 79.1

RIGHT ATRIAL PRESS.= -5 MM HG MEAN CAPILL.PRESS.= 4.1 MM HG

CARDIAC OUTPUT= 2.1 L/MIN. STROKE VOL.= 19.2 ML, HEART RATE= 110.

ART.RESIST.= 36.7 VENOUS RESIST.= 2.2 MM HG/L/MIN

CARDIAC CONTRACTILITY= 1.4 L/MIN/MM HG FILLING PRESS.

VALUES FOR THIS RUN WERE...

1..ART. RESISTANCE= 200.0 % OF NORMAL

2..VEN. RESISTANCE= 100.0 % OF NORMAL

3..CARDIAC CONTRACTILITY= 100.0 % OF NORMAL

4..MEAN INTRATHORACIC PRES.= -2.0 MM HG

5..BLOOD VOLUME= 3000.0 ML

(and the associated pain and mess), but the students can now perform a virtually unlimited number of experiments, repeat them several times, try a different treatment each time (or withhold treatment and study the natural course of events). These models have been presented to a wide medical audience and are being used at over 70 different medical schools around the world. In fact, MACMAN and his cousins speak five different languages.

He is "not feeling too well" and "his eyes are going dim." If the simulation were allowed to continue for another three minutes, MACMAN would die and we would have a post-mortem report.

The programs have all been written in standard Fortran and require interactive access to a suitable computer via ordinary (ASCII compatible) terminals. They have been implemented on a range of minicomputers and we plan to adapt them soon to microcomputers. A Basic version of MACMAN has also been developed. The other models have not been translated to Basic, owing to their complexity and high computation requirements.

Figure C The effect of a drug to raise blood pressure is simulated. MACMAN has recovered somewhat, his symptoms have improved.

```

DO YOU WANT TO 1.CHANGE, 2.CONTINUE, 3.RESTART, 4.STOP THE MODEL
71
1.CHANGE FACTORS, 2.BARORECEPTOR FUNCTION, 3.DISPLAYS
71
TYPE THE NUMBERS OF FACTORS (1-5) TO BE CHANGED
25 1
FACTOR 5 (CURRENTLY= 3000.0 ), SPECIFY NEW VALUE
74600
FACTOR 1 (CURRENTLY= 200.0 ), SPECIFY NEW VALUE
7100

DO YOU WANT TO 1.CHANGE, 2.CONTINUE, 3.RESTART, 4.STOP THE MODEL
72
TIME 0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300
SECS . . . . .
124          XXXX*XXXX
128          XXX*XXXXX
132          XX*XXXXXX
136          X*XXXXXXX
140          XX*XXXXXX
144          XX*XXXXXX
148          XX*XXXXXX
152          XX*XXXXXX
156          XX*XXXXXXX
160          XX*XXXXXX
164          XX*XXXXXX
168          XX*XXXXXX
172          XX*XXXXXX
176          XX*XXXXXX
180          XX*XXXXXX
    
```

THAT'S BETTER DOCTOR....
BUT ARE YOU GOING TO DO ANY OTHER NASTY THINGS TO ME ?

B.P. SYSTOLIC=109 DIASTOLIC= 71 MEAN= 84.2
RIGHT ATRIAL PRESS.= 1.2 MM HG MEAN CAPILL. PRESS.= 11.3 MM HG
CARDIAC OUTPUT= 4.6 L/MIN, STROKE VOL.= 55.6 ML, HEART RATE= 83.
ART. RESIST.= 16.6 VENOUS RESIST.= 2.2 MM HG/L/MIN
CARDIAC CONTRACTILITY= 1.5 L/MIN/MM HG FILLING PRESS.
VALUES FOR THIS RUN WERE...

1. ART. RESISTANCE= 100.0 % OF NORMAL
2. VEN. RESISTANCE= 100.0 % OF NORMAL
3. CARDIAC CONTRACTILITY= 100.0 % OF NORMAL
4. MEAN INTRATHORACIC PRES.= -2.0 MM HG
5. BLOOD VOLUME= 4600.0 ML

```

DO YOU WANT TO 1.CHANGE, 2.CONTINUE, 3.RESTART, 4.STOP THE MODEL
74
    
```

Figure D MACMAN is now given some blood and the drug is removed. He is feeling much better.

The development of the MAC family has been a very rewarding experience to our group. It has provided us a much better understanding of the human systems and in some cases corrected our thinking. As always happens, designing these simulations has pointed out many grey areas in our knowledge. To the student and researcher, this tool is invaluable as it enables them to experiment and test hypotheses — there is no better way to learn than to perform critical experiments. This development opens yet another exciting possibility — the use of simulation in the clinic. We have already built features in the advanced models to allow the user to specify the age, sex, height and weight of the simulated subject. It is then possible by trial and error to "tune-in" a given patient, and then try different treatment plans. We have had some success in this area, though the procedure is fairly in-

volved. We are currently working on making the models self-adjusting. Thus, one could enter the observed results (such as heart rate, blood pressure, levels of oxygen and carbon dioxide in blood, etc.) and let the model work out the other parameters to match the physical state of the actual patient. It would then be possible to predict the outcome of a treatment for a specific person more accurately. This could be a valuable tool for the future doctor and in the Intensive Care Unit.

We feel that computer simulation in medicine offers a lot of exciting possibilities and we are sure to witness new developments in the coming years — we have only begun to scratch the surface. Who knows, someday, you may dial up your 'family computer' about a problem in the middle of the night and out will come the answer "Take two aspirins and call me in the morning!" □

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Ecology: A Simulation Model for Small Populations of Animals.

James W. Grier

The impact of human activities on the populations of other species has been receiving increased interest and concern. The issue of the snail darter, a fish endangered by the proposed Tellico Dam, is probably the best known; but it is only one of numerous examples. Other cases involve the black-footed ferret, the timber wolf, some species of prairie chickens, the peregrine falcon, and many others: even our nation's symbol, the bald eagle.

Wildlife ecologists are developing new techniques for managing and attempting to save such species, by transplanting eggs, or young, or whole populations to different locations, or by breeding the species in captivity for reintroduction to the wild. Ecologists are also attempting to isolate and correct the most critical factors limiting the populations in the wild. A recent reference for work on birds is *Endangered Birds*, edited by S. A. Temple (Univ. of Wisc. Press, 1977).

One of the biggest problems in working with small populations, however, is the large part played by chance events — which can lead to several different outcomes. If one has only four animals — two females and two males, for example — and the expected mortality rate is 50 percent, the whole future of the population rests on which 50 percent dies. If by chance it is 1 female and 1 male, there is still a pair

left which may reproduce and increase the population severalfold. If, however, the two females die, only the males remain and the population is doomed.

Chance can enter the picture at several points. Not only which individuals die, but how many young each female produces and the sex of those young, are chance determinations which affect the fate of the population.

The problem with most population models is that they are *deterministic*, that is, they are determined by a fixed set of values with no room for chance and with only one outcome. A classic example of such a model is the age-specific life table (for a reference, see C. J. Krebs, *Ecology*, Harper and Row, 1978, Chapter 10). These models may be useful for large populations, where the effects of chance can usually be ignored, but they simply are not realistic or useful for small populations. Most of the mathematical models that do allow for the variation caused by chance (called stochastic models) are either too simple to be realistic or too complex and restrictive to be of much use.

Monte Carlo Techniques and Basic's random function, RND, provided a solution to the problem. I first worked up a simple model that could be done by hand using the flipping of coins and a random numbers table. I used that for an ecology class laboratory exercise and gained enough experience with it to develop a larger, more complete computerized version. I developed the first computer program

specifically for birds of prey (hawks, eagles, falcons and owls). It had two purposes: to stimulate and evaluate the probability of success of reintroducing peregrine falcons into the eastern United States, and to predict the fate of certain bald eagle populations, the species I have worked with mostly myself. The program had several options and permitted repeated simulations — something that a wildlife manager cannot do with the real thing. In real situations — wildlife trans-

One of the biggest problems in working with small populations is the large part played by chance events — which can lead to several different outcomes.

plants, reintroductions or the survival of a remnant population — there may be only one chance. In the computer the situation can be run hundreds or thousands of times to determine the likely range of outcomes.

After completing that program I decided to modify it to be useful for a wider range of species. The initial program assumed monogamous breeding (one male, one female); but many species are polygamous, so I added an option for that. The termin-

ology was changed to apply to all animals. The revised model still contains several more or less restrictive assumptions (Table 1), but it fits a large number of species and the program could be modified to make room for differences. The only real constraint in the model at present involves the number of young per female. The model gets increasingly awkward with increasing maximum numbers of young. Most species for which this model is intended produce only one to ten young at a time, and the program works fine. For species with larger numbers, the sections on reproduction (statements 620 to 730 and 2370 to 2640) could be modified. The flow chart is shown in Figure 1.

The revised program has now been used successfully in real applications, has become very popular for instructive purposes, and may even be used as a game. Life is most stimulating when one can mix work with pleasure, and this program has turned out to satisfy this ideal. By asking for information which often is not known,

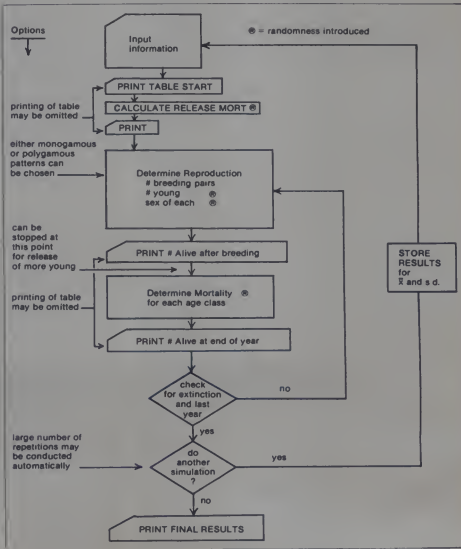
The program had several options and permitted repeated simulations — something that a wildlife manager cannot do with the real thing.

it points out and emphasizes the need for further research. In the meantime, and to better understand the model and what might happen under various situations, one can easily provide hypothetical values.

The program and some sample runs are provided here. The program contains about 300 statements and 10,000 characters. If that is too much for a user's available memory, it can be greatly shortened by separating out the comments and by eliminating some of the options, such as those that permit automatic repetition. I also have written 1) a companion deterministic program that shows what happens, in a similar format, when chance is removed and 2) a program (oriented toward birds) for life tables. Both of those programs are free from me on request. □.



- 1) Breeding is seasonal and more or less synchronized in the population so that all birth or hatching occurs within a relatively short period.
- 2) If monogamous breeding is chosen, the number of breeding pairs is limited by the sex with the least number of adults; otherwise it is limited by the number of adult females, assuming that at least one male is present.
- 3) Members of potential pairs can find each other for purposes of breeding and are behaviorally/physiologically capable of breeding.
- 4) There are no inbreeding problems.
- 5) No density-dependent effects limit the population growth (although computer time might).
- 6) All of the mortality occurs outside the reproductive season. (And only those young that fledge or are weaned are counted in the first place. This eliminates those that die in the uterus, nest, etc. and permits the assumption to be fairly reasonable.)
- 7) Male and female mortality rates are the same.
- 8) Mortality rates are constant (within the random limits) for animals over one year of age. This assumes that the animals do not reach senility, and die from physiological old age in the wild.
- 9) The mortality and reproductive rates do not change significantly over time, that is, during the years of simulation.



END OF THIS SIMULATION. YOUR FINAL POPULATION
IS 2 PEREGRINE FALCONS.

TABLE 3 PEREGRINE FALCONS ALIVE FOR EACH YEAR OF SIMULATION.

YEAR	FIRST YEAR	SECOND YEAR	THIRD YEAR	ADULT MALES	ADULT FEMALES	TOTAL
0	0	4	0	0	0	12
1	0	1	0	0	0	1
2	0	0	0	1	0	1
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0

THIS POPULATION OF PEREGRINE FALCONS DID NOT SURVIVE.

YOU RUN 3 SIMULATIONS.
THE NEAR FINAL POPULATION OF PEREGRINE FALCONS
WAS 12.5 PEREGRINE FALCONS.
WITH A STANDARD DEVIATION OF 7.
THERE WERE (MAG) 1 SIMULATIONS THAT WENT TO EXTINCTION.

SEE YA.

TIME 4.6 SECS

RUN

7 SP0 10/22/79 13184131

888 A STOCHASTIC MODEL FOR SMALL POPULATIONS 888

BY JAMES W. GELER

ZOOLOGY DEPT., NDSU, FARGO ND 58105

DO YOU WANT INTRODUCTORY COMMENTS (1=YES, 2=NO)?

DO YOU WANT THE SIMULATION AUTOMATICALLY
REPEATED MORE THAN ONCE (1=YES, 2=NO)?

NOW MANY TIMES DO YOU WANT THE SIMULATION REPEATED

100 IF THE PROGRAM STOPS ANYTIME BECAUSE YOU EXCEEDED
THE CPU LIMIT, HIT RETURN AND THE TABLE WILL
CHOOSE HOW MANY TIMES TO NOT HAVE THE TABLE PRINTED (1=YES,
2=NO). PRINT THE TABLE 2 TIMES. DO NOT PRINT THE TABLE AT ALL?

WHAT SPECIES ARE YOU WORKING WITH?

PEREGRINE FALCON

HOW MANY ADULT MALES DO YOU WANT TO START WITH?

4

HOW MANY ADULT FEMALES DO YOU WANT TO START WITH?

0

WHAT IS THE MAXIMUM NUMBER OF YEARS PER BREEDING FEMALE

4

WHAT PERCENT OF THE ADULT FEMALES PRODUCE 0 YOUNG?

20

WHAT PERCENT OF THE ADULT FEMALES PRODUCE 1 YOUNG?

30

WHAT PERCENT OF THE ADULT FEMALES PRODUCE 2 YOUNG?

30

WHAT PERCENT OF THE ADULT FEMALES PRODUCE 3 YOUNG?

30

WHAT PERCENT OF THE ADULT FEMALES PRODUCE 4 YOUNG?

0

WHAT IS THE ESTIMATED FIRST YEAR MORTALITY RATE

FOR PEREGRINE FALCON?

0

WHAT IS YOUR GUESS FOR THE ANNUAL

DEATH RATE OF OLDER PEREGRINE FALCON?

0

NOW MANY YEARS DO YOU WANT THE SIMULATION TO RUN?

5

NOW WANT MALE AND FEMALE OF THE YEAR ARE YOU
ALREADY RELEASED (SPECIFY BOTH, SEPARATE WITH COMMA)?

DO YOU WANT TO RELEASE ANY OLDER PEREGRINE FALCONS (1=YES, 2=NO)?

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Exciting, entertaining software for the Apple II and Apple II Plus*



If you liked "Invaders", you'll love **ASTEROIDS IN SPACE** by Bruce Wallace. Your space ship is traveling in the middle of a shower of asteroids. Blast the asteroids with lasers, but beware — big asteroids fragment into small asteroids! The Apple game paddles allow you to rotate your space ship, fire its laser gun, and give it thrust to propel it through endless space. From time to time you will encounter an alien space ship whose mission is to destroy you, so you'd better destroy it first! High resolution graphics and sound effects add to the arcade-like excitement that this program generates. Runs on any Apple II with at least 32K and one disk drive. On diskette — **\$19.95**

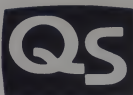


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670 INPUT "WHAT IS THE MAXIMUM NUMBER OF YOUNG PER BREEDING FEMALE="
680 PRINT N
690 PRINT "WHAT PERCENT OF THE ADULT FEMALES PRODUCE YOUNG?"
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Pursuit Games, CS-3004 (16K)

- **Stock Car Race** \$7.95

Stock Car Race is a real time racing game on a road race circuit. Your high speed racer is controlled by the "arrow" keys, as you shift up and down through four gears. Take the turns slowly, "floor it" on the straights, but don't blow your engine!

- **Maze**

Maze for the Level II 16K machine is a high speed pursuit game. You are timed throughout your run and rated on the basis of elapsed time and the number of moves required to escape. A different maze every time. Nine skill levels.

- **Indy Racer**

Indy Racer is a real time racing game for the TRS-80. You're in the driver's seat of a red-hot Indy car, changing gears and weaving around the track as you pass your competitors. Indy Racer is similar to the popular arcade-style driving games.

- **Depth Charge**

As commander of a destroyer, your mission is to destroy as many enemy subs as possible. Move your ship back and forth on the water, positioning yourself over enemy subs as they cruise into range. Depth charges sink slowly, so timing and position are important in this re-creation of the Battle of the Atlantic.

- **Kaleidoscope**

This graphics demonstration program turns your TRS-80 into a computer age kaleidoscope. You enter the number of lines and size of the display to produce changing patterns on the video monitor. Truly hypnotizing, Kaleidoscope runs continuously to brighten up your home or office.

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Space Games-3, CS-3002 (16K)

- **Ultra-Trek** \$7.95

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- **Star Lanes**

Imagine yourself the president of an intergalactic shipping company. If you're successful, you may be named Imperial Advisor on Economic Affairs. Entrepreneurs: to your ships.

- **Star Wars**

If you hate Darth Vader, you'll love Star Wars. This real time game is fun for aliens of all ages. May the Force be with you!

- **Romulan**

Your mission is to destroy an invading Romulan space craft. Maneuver through space and around stars looking for the deadly enemy, but be careful! The nasty Romulans fire back.

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Economic and Ecology Simulations

The Ecology Simulations series are a unique educational tool. They are based on "method models" developed by the Huntington Two Computer Project at the State University of New York at Stony Brook under the direction of Dr. Ludwig Braun. The programs and accompanying documentation are written for self-teaching or classroom use and include background material, sample exercises and study guides. Graphic displays were specially developed by Jo Ann Comito at SUNY and Ann



Corrigan at Creative Computing. The Ecology Simulations packages are a remarkable educational application of micro-computers.

Ecology Simulations-1, CS-3201 (16K)

1. Pop

The POP series of models examines three different methods of population projection, including exponential, S-shaped or logistical, and logistical with low density effects. At the same time the programs introduce the concept of successive refinement of a model, since each POP model adds more details than the previous one.

2. Steri

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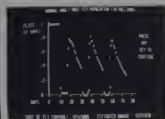
methods is introduced. In addition, STERL demonstrates the effectiveness of an integrated approach over either alternative by itself.

3. Tag

TAG simulates the tagging and recovery method that is used by scientists to estimate animal populations. You attempt to estimate the bass population in a warm-water, bass-bluegill farm pond. Tagged fish are released in the pond and samples are recovered at timed intervals. By presenting a detailed simulation of real sampling by "tagging and recovery," TAG helps you to understand this process.

4. Buffalo

BUFFALO simulates the yearly cycle of buffalo population growth and decline, and allows you to investigate the effects of different herd management policies. Simulations such as BUFFALO allow you to explore "What if" questions and experiment with approaches that might be disastrous in real life.



Ordering Information

The series is designed for the 16K TRS-80 Level II and is attractively packaged in a vinyl binder with a complete study guide. Ecology Simulations-I: disk CS-3501, cassette 3201. Ecology Simulations-II: disk CS-3502, cassette CS-3204. Social and Economic Simulations: disk CS-3508, cassette CS-3204. At a modest \$24.95 each, the series is an affordable necessity.

To order, send payment plus \$1.00 shipping and handling to Creative Computing Software, Dept. ACGG, P.O. Box 789-M, Morristown, NJ 07960. For Faster Service, call in your order toll-free to our order hotline 800-631-8112. In NJ call 201-540-0445.

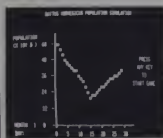
Ecology Simulations-2, CS-3202 (16K)

1. Pollute

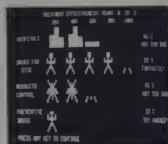
POLLUTE focuses on one part of the water pollution problem, the accumulation of certain waste materials in waterways and their effect on dissolved oxygen levels in the water. You can use the computer to investigate the effects of different variables such as the body of water, temperature, and the rate of dumping waste material. Various types of primary and secondary waste treatment, as well as the impact of scientific and economic decisions can be examined.

2. Rats

In RATS, you play the role of a Health Department official devising an effective, practical plan to control rats. The plan may combine the use of sanitation and slow kill and quick kill poisons to eliminate a rat population. It is also possible to change the initial population size, growth rate, and whether the simulation will take place in



an apartment building or an entire city.



3. Malaria

With MALARIA, you are a Health Official trying to control a malaria epidemic while taking into account financial considerations in setting up a program. The budgeted use of field hospitals, drugs for the ill, three types of pesticides, and preventative medication, must be properly combined for an effective control program.

4. Diet

DIET is designed to explore the effect of four basic substances, protein, lipids, calories and carbohydrates, on your diet. You enter a list of the types and amounts of food eaten in a typical day, as well as your age, weight, sex, health and a physical activity factor. DIET is particularly valuable in indicating how a diet can be changed to raise or lower body weights and provide proper nutrition.

Social and Economic Simulations CS-3204 (16K)

1. Limits

LIMITS is a micro-computer version of the well known "Limits to Growth" project done at MIT. It contains a model of the world that is built of five subsystems (population, pollution, food supply, industrial output, and resource usage) linked together by six variables: birth rate, death rate, pollution generation, resource usage rate, industrial output growth rate, and food production rate.

2. Market

Market allows two or more people to play the roles of companies who are competing

for the market for a particular product: in this case, bicycles.

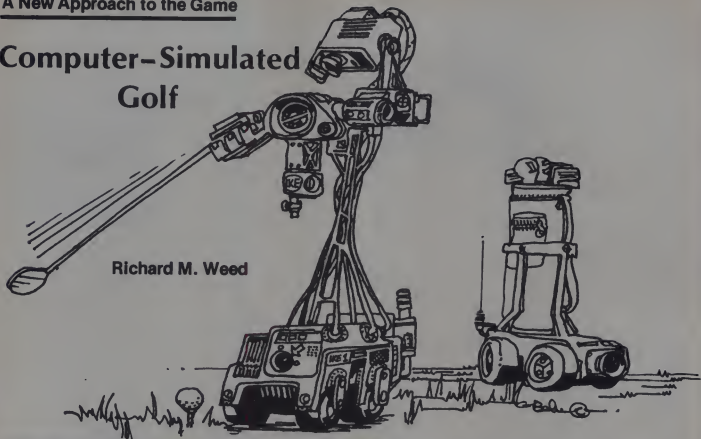
Each player makes marketing decisions quarterly including the production level, the advertising budget, and the unit price of the product for his/her company.

3. USPOP

USPOP allows the user to study many aspects of the United States' human demography (population change) including population growth, age and sex distribution. USPOP makes population projections and investigates the consequences of many different demographic changes.

Computer-Simulated Golf

Richard M. Weed



Computer simulation resolves an age-old controversy regarding playing strategies. The author, a consulting engineer who specializes in applications of statistical analysis, has published several technical papers and a textbook on the uses of computer simulation. The study described in this article was undertaken as part of a graduate program in applied statistics.

Background

For years, serious golfers have debated whether it is better to charge or lag the longer putts. If the putt is for a tie at match play, there is no question that it should not be left short, but what about stroke play? And what about long putts for a win at match play? The player must try to make these putts but, when he misses, he must not leave the ball so far past the cup that he is liable to miss the shot coming back. This is clearly a strategy situation which suggests that an optimum strategy can be found.

Bobby Jones, one of the foremost players of his day, believed it was bet-

ter to lag and, more recently, Jack Nicklaus has expressed similar thoughts. On the other hand, who can deny the success of Arnold Palmer, one of the boldest putters the game has known? Ask a number of experienced golfers whether it is better to charge or lag and you will receive a variety of very opinionated answers ranging from one extreme to the other. To resolve this controversy, the following questions must be answered:

- Is there a single best putting strategy in any given situation?
- Is the best putting strategy different for different players?
- How does the length and type of putt determine the best strategy?

One way to answer these questions would be to have a number of golfers hole out many times using different strategies from varying distances on greens of various types. The total number of putts would be recorded to determine which strategy required the fewest strokes in the long run. However, a moment's reflection on the logistics of conducting such an experiment would discourage most people from trying it. The optimum putting strategy may be influenced by a particular golfer's ability in terms of distance and directional control so it would be necessary to measure these accurately for each of the participants.

Golfers of different abilities would have to try various strategies from numerous distances under essentially identical conditions. This would be complicated by a gradual deterioration of the putting surface as more and more putts were attempted. A further complication would be the tendency for some players to improve throughout the duration of the experiment. Even if these technical difficulties could be overcome, the manpower, time and record keeping requirements would still be formidable obstacles.

Until recently, there was no other way a problem such as this could have been solved. Now, with the aid of modern computer technology, complex experiments of this type can be conducted in a matter of minutes by computer simulation.

How Computer Simulation Works

To understand how computer simulation works, suppose we wished to answer a question such as "What is the probability of throwing two heads in a row with a fair coin?" We really wouldn't need computer simulation to answer a simple question such as this because the probability can be calculated quite readily as $(\frac{1}{2})(\frac{1}{2}) = \frac{1}{4} = 25\%$. However, if we did choose to tackle it by simulation, we would first

Richard M. Weed, 61 Nancy Lane, Trenton, NJ 08638.

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Golf, cont'd...

have to develop a random process which behaves exactly like the coin toss. Since a single toss of a fair coin has a 50% probability of producing a head, we could simulate this by drawing a single value from a table of random numbers ranging from 1 to 100 and calling the result a head if the random number is 50 or less. By drawing two random numbers, we could simulate the tossing of the coin twice and, if both numbers are 50 or less, we have accomplished the equivalent of throwing two heads. By repeating this procedure many times and counting the

with that of a person performing the same task. For the experiment just described, 10,000 repetitions amount to 20,000 single tosses of the coin. A person might be expected to make and record about 10 tosses per minute and, at most, would work about 50 minutes out of each hour, 8 hours per day. At this rate, a total of 5 days would be required. In contrast to this, the computer can complete this entire experiment in less than 5 seconds! It is this remarkable capability that makes computer simulation one of the most useful tools of modern science.

In order to apply this technique to our golf problem, three preliminary tasks must be accomplished. First, putting ability must be defined in a quantitative way that will be meaningful to the computer. Next, a mathematical way to describe the rolling of a golf ball into the cup must be found. Finally, a method to instruct the computer to try different putting strategies must be developed. All three of these tasks will be seen to be easier than might at first be expected.

First Task

Putting ability can be characterized by two variables, distance and direction. In order to describe a player's putting ability in terms of these variables, it is necessary to introduce a statistical term called the standard deviation. The standard deviation is a measure of how close a player can come, on the average, to what he aims at. The smaller the standard deviation, the better the player.

For those not familiar with the standard deviation and the manner in which it is calculated, the following example will provide a more intuitive feeling for what it represents. To determine his ability to lag a putt a given distance, suppose a player lays a string across a carpet and, from a distance of 20 feet or so, tries to hit each putt so that it will stop exactly at the string. Let's say the player putts at the string 30 times, each time recording the distance the putt actually traveled. Although very few putts may stop exactly at the string, the average length of travel of the 30 putts will be found to be quite close to the desired

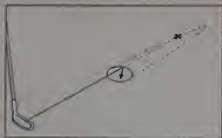


Figure 1. The Sink Zone

distance of 20 feet. Furthermore, there is a statistical rule which tells us that nearly all the putts will be within plus or minus three standard deviations from this average point, about 95% will fall within plus or minus two standard deviations, and approximately two thirds will lie within plus or minus one standard deviation. In this example, if we found that 20 of the 30 putts were within plus or minus one foot from the string, we would know that the standard deviation was about one foot. (Although the standard deviation can be estimated in this manner, direct calculation is best. Many hand calculators provide this capability.)

To simplify the application of this information to putts of lengths other than that used in the test, we will express the standard deviation in relative terms, that is, as a percentage of the length of the putt. If the standard deviation for a 20 foot putt has been estimated at 1.0 foot, the relative standard deviation would be $1.0/20 = 5\%$. Experimentation has shown that the relative standard deviation for the distance of a putt is nearly constant, being effected negligibly by the length of the putt and only slightly by the speed of the green.

The standard deviation for directional accuracy is determined in a

For years, serious golfers have debated whether it is better to charge or lag the longer putts.

number of times the equivalent of two heads is obtained, it would be possible to obtain a very accurate estimate of the desired probability. (If this experiment actually were performed 10,000 times, it would nearly always produce an answer between 24% and 26%.)

Upon reading this, your first thought might be that it would be just as simple to toss an actual coin and not bother with the random number table. This would be true if we had to make the random selections ourselves but, fortunately, the computer will do this for us. In fact, it is a simple matter to program the computer to perform the complete experiment, count the number of times two heads are obtained, convert this to a percentage and print out the answer. If we wish, we can even have the program calculate confidence limits about the experimental result so that we would know the maximum amount the true answer might deviate from the experimentally-derived result. For this example, the computer might have printed out $24.5 \pm 1.0\%$, a range which includes the true value of 25%.

For those not familiar with the tremendous efficiency of modern digital computers, it is interesting to compare the speed of the computer

VARIABLE	DESCRIPTION	VALUE
1	Number of putts to be attempted	1000
2	Length of putt	20 ft.
3	Directional ability (relative standard deviation)	4%
4	Distance ability (relative standard deviation)	8%
5	Length of sink zone	7 ft.
6	Maximum length for charging strategy	5 ft.
7	Maximum length for intermediate strategy	10 ft.

TABLE 1. A POSSIBLE SET OF INPUT VARIABLES



"Guess what, Dad, at Buddy's house all his games come in cardboard boxes and he doesn't even need a computer to play them!"

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Figure 2. Establishing the Sink Zone

similar manner. In this case, the player putts at a target on a flat, true surface and the deviations left or right as the ball passes the target are recorded. As before, a relative standard deviation is calculated by dividing by the length of the putt.

Both relative standard deviations should be obtained from the same series of tests. This not only speeds up the process but provides a more realistic measure of how well a player can perform when he must be concerned about distance and directional accuracy simultaneously. (Ideally, this test should be performed on a putting green. However, it may be done on a carpet provided the player realizes that the results may be slightly better than he can expect to achieve on an actual green.)

This completes the first task, the development of a quantitative way to define putting ability. The relative standard deviations for distance and directional control will be among the input variables for the computer program, making it possible to simulate the testing of players of various abilities.

Second Task

The next task, finding a mathematical way to describe the rolling of a golf ball into the cup, is quite simple in concept. Basically, it consists of defining a "sink zone" which includes the cup and the area immediately behind it as shown in Figure 1. A putt which will drop into the side of the cup must be traveling very slowly as it reaches the cup whereas a putt hit into the center of the cup can be moving much more rapidly. The outer limits of the sink zone represent the maximum distance a successful putt would have rolled past the cup if the cup had not been there to catch it. Once the sink zone has been described in mathematical terms within the computer program, any simulated putt which stops within this area will be considered to have fallen into the cup.

It was necessary to establish the sink zone experimentally, using the ramp-type device shown in Figure 2. All sink zones were found to be of the shape shown in the figure although, as was expected, they extend for a greater distance past the cup on faster greens. In order to account for the speed of the green in the simulated putting experiment, the length of the sink zone will be included among the variables entered into the computer program.

Third Task

The final preparatory task is the easiest of the three. In order to compare the relative effectiveness of charging and lagging, these strategies must be described in a quantitative way. For a complete lagging strategy, approximately 50 percent of the total number of putts attempted will reach the cup. For a complete charging strategy, 100 percent will reach the cup. In order to provide an additional measure of realism, an intermediate strategy will also be included for which 75 percent of the putts will reach the cup. Since the relative standard deviation for distance is entered into the program, it is a simple matter for the computer to calculate

what the average distance must be so that there is a 50, 75, or 100 percent chance of reaching the cup on any simulated putt.

In order to test different strategies, the computer must be told over what ranges of distance these three strategies are to be applied. For example, if it were desired to charge every putt up to 5 feet in length and be moderately aggressive between 5 and 10 feet, this can be accomplished by entering the two limiting distances, 5 feet and 10 feet, into the program. When this is done, the program will attempt to hit each simulated putt so that no 5 footers are left short and only about 25 percent of the 5 to 10 footers will be short. Above 10 feet, the lagging strategy will be in effect. In this manner, a wide variety of strategies ranging from very conservative to very bold can be tested.

The Simulation Experiment

In order to describe how the program actually conducts the experiment, it will be instructive to examine a possible set of input variables as shown in Table 1. This is all the information the computer needs to conduct one series of putting tests. Variables 1 and 2 tell the computer to hole out from a distance of 20 feet a total of 1000 times. Variables 3 and 4 specify a very good player in terms of distance and directional accuracy.

A wide variety of strategies ranging from very conservative to very bold can be tested.

Variable 5 represents a moderately fast putting surface with a sink zone length of 7 feet. Variables 6 and 7 indicate that a charging strategy is to be used on all putts up to 5 feet in length and an intermediate strategy is to be used between 5 feet and 10 feet. All putts longer than 10 feet will automatically be lagged.

For each simulated putt, the computer generates two normally distributed random numbers. These numbers, when combined with the dis-



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PUTTS REQUIRED TO HOLE OUT	OCCURRENCES	STROKES
1	87	87
2	889	1778
3	24	72
4	0	0
MORE THAN 4	0	0
	1000	1937

STROKE AVERAGE = 1.937

TABLE 2. TYPICAL COMPUTER OUTPUT

ABILITY LEVEL	STANDARD DEVIATIONS (%)		DESCRIPTION
	DIRECTION	DISTANCE	
A	2	4	EXCELLENT PLUS
B	3	6	EXCELLENT
C	4	8	VERY GOOD
D	5	10	GOOD
E	6	12	FAIR

TABLE 3. LEVELS OF PUTTING ABILITY

tance to the cup, the relative standard deviations, and the desired strategy, determine the direction and distance the simulated putt travels. The program then calculates the point at which the putt stops and, if it is within the sink zone, the putt is considered to have fallen into the cup. Otherwise, the remaining distance between the ball and the cup is calculated, two more random numbers are drawn, and another simulated putt is made using the appropriate strategy from that point. This procedure is repeated until the putt is successfully holed out for each of the 1000 attempts.

The output for this run might appear as shown in Table 2. For this particular test, the player holed out on the first putt a total of 87 times, two putted 899 times, and three putted 24 times for a stroke average of 1.937. If some alternate strategy were to produce a stroke average of 1.783, for example, it would be considered a superior strategy because, on the average, fewer strokes were required. By trying several strategies ranging from very conservative to very bold, it will be possible to determine the optimum strategy if one exists.

To make the simulation more like an actual round of golf, an additional refinement must be added. Instead of specifying the initial length of each putt to be exactly 20 feet, we will instruct the computer to create a random distribution of putts similar to that which would be encountered in actual play. The average length of putt will still be approximately 20 feet but the individual putts will range in length from nearly zero up to a maximum of about 100 feet. This will allow us to evaluate our test strategies in terms of the effect they would have on an 18-hole round of golf.

Validation of the Program

Now there is only one step remaining before we can use a program to answer our questions about putting strategies. This is the validation step which simply means we must verify that the simulation program is a realistic model of the real process. If this article were written for a scientific journal, it would be necessary to devote a lengthy section to

this topic. For our present purposes, it will suffice to briefly describe how this is accomplished.

Since we have complete control of the variables that are entered into the program, we can use slightly unrealistic values for which the results can be predicted in advance. For example, the directional standard deviation can be set at zero so that every simulated putt is exactly on line. A judicious choice of the other variables will enable us to predict how many times the player should hole out in one stroke. Then, provided the simulation outcome is not significantly different from the expected result, we would conclude that the program was working properly. A variety of different tests of this type were performed, all of which indicated that the program was operating correctly.

Ability and Strategy Levels

Since there are so many possible combinations of playing abilities and putting strategies, it will be necessary to define a manageable number of distinct groups. Experience has shown that a player's directional control is approximately twice as good as his control of distance. This information was used to establish the five ability levels listed in Table 3.

The top ability level is described as "excellent plus" because it is believed that few players can attain this degree of control. A touring professional might achieve it on a flat, consistent surface such as a carpet but more likely would fall into Ability Level B on an actual putting green. Better than average club players would probably fall into Ability Level C.

By remembering the rule about standard deviations, a player can

estimate his ability without conducting an actual putting test. Since approximately 95% of the putts will come within plus or minus two standard deviations of the target, a player has only to estimate how widely dispersed the best 5% of his putts are. For example, if he is seldom off line by more than two feet to either side on a 20 foot putt, two feet equals two standard deviations and the standard deviation is one foot. In relative terms, it is $1/20 = 5\%$ and, from Table 3, we see that a directional standard deviation of 5% corresponds to Ability Level D.

The standard deviation is a measure of how close a player can come, on the average, to what he aims at.

The putting strategies will also be divided into distinct groups. The intermediate strategy will be assumed to apply up to twice the maximum length for the charging strategy. For example, if the player plans to charge all putts up to 10 feet in length, he will use the intermediate strategy on putts between 10 and 20 feet in length. Putts longer than 20 feet would be lagged. The seven strategies to be tested are listed in Table 4.

The strategies range from very conservative to very bold so that all possibilities can be thoroughly investigated. For Strategy 1, the player charges putts up to 2 feet in length and begins lagging above 4 feet. For Strategy 7, the player charges everything up to 30 feet and doesn't begin to lag until the putt is over 60 feet in length.

For each of the 35 possible combinations of ability level and strategy, a minimum of 2000 simulated putting tests were conducted. In the critical regions near the optimum strategies, the number of tests was doubled. A seven foot sink zone was used for the main group of tests although additional tests with other lengths pro-

STRATEGY	RANGES FOR PARTICULAR STRATEGIES (FT.)			DESCRIPTION
	CHARGE	INTERMEDIATE	LAG	
1	0-2	2-4	OVER 4	VERY CONSERVATIVE
2	0-4	4-8	OVER 8	—
3	0-6	6-12	OVER 12	CONSERVATIVE
4	0-10	10-20	OVER 20	—
5	0-15	15-30	OVER 30	BOLD
6	0-20	20-40	OVER 40	—
7	0-30	30-60	OVER 60	VERY BOLD

TABLE 4. PUTTING STRATEGIES

Golf, cont'd...

duced essentially the same results. All in all, the computer simulated holing out from varying distances a total of 130,000 times. (A group of 25 golfers might have required about a month to accomplish this. The computer required just about 11 minutes.

Table 5 lists the stroke average for each combination of strategy and ability level. Here we see that optimum strategies do exist and that they are dependent upon a player's putting ability.

Since Ability Level B most nearly resembles the capability of a tour player on an actual putting surface, it will be interesting to examine these results more closely. We see that the lowest stroke average of 1.764 is obtained with Strategy 4 and that Strategy 5 produces very nearly the same result. Therefore, a player of this level of ability would score best by being fairly bold.

To appreciate the importance of the optimum putting strategy, it is necessary to determine the effect it has on an 18-hole round and a 72-hole tournament. A player of Ability Level B who uses the optimum putting strategy will require $1.764 \times 18 = 31.8$ putts per round, on the average. (This is a reasonable result for a tour player and provides added assurance that the simulation program is realistic.) If this same player elected to use a very conservative approach such as Strategy 1, he would require $1.845 \times 18 = 33.2$ putts per round, on the average. The difference of 1.4 putts per round corresponds to almost 6 strokes for a 72-hole tournament. With today's purses, this would amount to a loss of

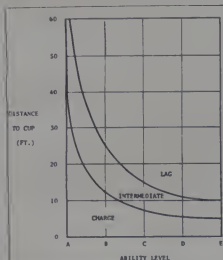


Figure 3. Optimum Strategy as a Function of Ability

	STRATEGY						VERY BOLD
	VERY CONSERVATIVE	CONSERVATIVE	BOLD	VERY BOLD			
ABILITY LEVEL	1	2	3	4	5	6	7
A (EXC. PLUS)	1.732	1.707	1.685	1.665	1.648	1.634	1.622
B (EXCELLENT)	1.845	1.804	1.777	1.764	1.767	1.784	1.816
C (VERY GOOD)	1.944	1.894	1.873	1.879	1.914	1.976	2.087
D (GOOD)	2.060	2.016	2.006	2.030	2.087	2.179	2.305
E (FAIR)	2.158	2.124	2.130	2.176	2.261	2.387	2.553

TABLE 5. STROKE AVERAGE AS A FUNCTION OF ABILITY AND STRATEGY

several thousand dollars in prize money!

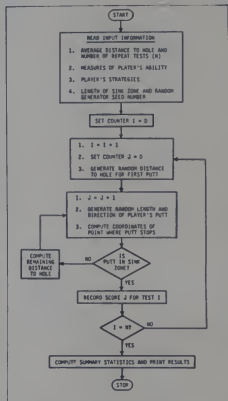
The results of this study can best be summarized by the graph in Figure 3 which has been plotted from the data in Tables 4 and 5. Here we see that better putters can afford to be more aggressive while those with less ability should be more conservative. For example, the curves indicate that a player of Ability Level B should charge all normal putts up to a length of about 12 feet and be moderately aggressive up to about 25 feet. If a player could consistently perform at Ability Level A, he should charge all

Finding a mathematical way to describe the rolling of a golf ball into the cup is quite simple in concept.

most any length putt. At the other end of the scale, a player of Ability Level E should still charge putts up to 5 feet in length and begin lagging at about 10 feet.

A word of caution is in order at this point. The optimum strategy is appropriate as long as the initial assumptions are met. However, if the putt has a large amount of break, the player's directional ability is likely to suffer. If the putt is downhill, the distance will be more difficult to control. In effect, conditions such as these can shift a player to a lower ability level and, as seen in Figure 3, this suggests a more conservative approach.

There is an additional aspect of tournament strategy that should be mentioned. Although the optimum strategy as defined in this study will allow a tour player to achieve the lowest stroke average of which he is capable, a somewhat bolder strategy may be required to maximize his chances of winning a tournament. However, because of the potentially disastrous outcome of an overly aggressive approach, this must be pursued with caution. To determine how productive a bolder strategy might be, a modification of the simulation program would be required. □



"The error isn't my fault; according to the computer's biorhythm chart, today is a critical day for it."

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CIRCLE 181 ON READER SERVICE CARD

Golf, cont'd...

Enter once for a series of runs

run puts in text
EXECUTION BEGINS...

ENTER SINK ZONE (FT.), DIR. S.D. (Z), DIST. S.O. (Z), AND SEED NUMBER

2 4 1234567

ENTER LENGTH FACTORS A, B, AND C FOR TRANSFORMATION $L = (A * B * C) * C$

1 3.5 2.34

This creates a skewed distribution of putts ranging in length from almost zero to about 100 feet with an average length close to 20 feet.

ENTER CHARGE AND SEMI-CHARGE DISTANCES (FT.) AND FORMAT CODE

2 4 2

SINK ZONE = 7.0 FT.

A = 1.00 B = 3.5 C = 2.34

DIRECTION STD. DEV. = 2.0% DISTANCE STD. DEV. = 4.0%

LONGEST PUTT = 86.61 FT. SHORTEST PUTT = 0.83 FT.

AVERAGE LENGTH = 20.76 FT. SKEW COEFFICIENT = 1.05

PUTTS REQUIRED

FREQUENCY

1	280
2	717
3	3
4	0
4+	0

AVERAGE NUMBER OF PUTTS REQUIRED = 1.723

ENTER CHARGE AND SEMI-CHARGE DISTANCES (FT.) AND FORMAT CODE

Duplicate runs for each strategy in order to check

"within strategy" variability. As seen here, results tend to be quite close.

SINK ZONE = 7.0 FT.

A = 1.00 B = 3.50 C = 2.34

DIRECTION STD. DEV. 2.0% DISTANCE STD. DEV. = 4.0%

LONGEST PUTT = 108.39 FT. SHORTEST PUTT = .019 FT.

AVERAGE LENGTH = 21.35 FT. SKEW COEFFICIENT = 1.18

PUTTS REQUIRED

FREQUENCY

1	265
2	734
3	1
4	0
4+	0

AVERAGE NUMBER OF PUTTS REQUIRED = 1.736

Program Sample Run (Original Program in Fortran)

RUN PUTS IN

EXECUTION BEGINS...

ENTER AVERAGE LENGTH (FEET) OF FIRST PUTT AND NUMBER OF TESTS

20 1000

ENTER STANDARD DEVIATIONS (Z) FOR DISTANCE AND DIRECTION

8 4

ENTER CHARGE AND SEMI-CHARGE LIMITS (FEET)

10 20

ENTER LENGTH (FEET) OF SINK ZONE AND RANDOM GENERATOR SEED NUMBER

7 1234567

LONGEST FIRST PUTT = 86.61 FEET

AVERAGE LENGTH = 20.76 FEET

SHORTEST FIRST PUTT = 0.83 FEET

SKEW COEFFICIENT = 1.05

PUTTS REQUIRED

FREQUENCY

1	177
2	750
3	71
4	2
4+	0

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combinations is reduced by one power of 3.

Finally, lines 400 through 570 are seven nested FOR-NEXT loops that print the possible combinations. The innermost loop is for the last character so the resulting strings are in alphabetical order. Line 500 forces a carriage return when there is insufficient room for another string on the current line.

Enhancements, you say. Very few, except possibly checking for dirty words. ☐

Listing 1

```

20 REM PHONE - CONVERT PHONE NUMBER TO LETTERS
30 REM SSC V1.2 8-23-79
30 INPUT "OUTPUT TO PRINTER",Z$
40 LL=PEEK(HEX("AC04")):REM Get page width
50 IF LEFT(Z$,1)<>"Y" THEN LL=7
60 OPEN "O.PRINT.SYS" AS O
70 EXEC, "TTYSET PS=N"
80 INPUT "ENTER LINE LENGTH",LL
90 LL=LL-7
100 IF LL<7 THEN LL=73:REM default to 80 cols.
110 DIM LS(9):REM LETTERS ON PHONE DIAL
120 DIM P(6)
130 DATA O,I,ABC,DEF,GHI,JKL,MNO,PRS,TUV,XYZ
140 FOR I=0 TO 9:READ LS(I):NEXT I
150 INPUT "Enter phone number",PS
160 IF LEN(PS)=7 GOTO 190
170 PRINT "Enter 7 digits"
180 GOTO 150
190 REM Get the digits as numbers
200 FOR I=0 TO 6
210 REM Convert digit to integer
220 P(I)=ASC(MID$(PS,I+1,1))-ASC("0")
230 IF P(I)>=0 AND P(I)<10 THEN GOTO 260
240 PRINT "Bad digit -- Try again"
250 GOTO 150
260 NEXT I
270 REM Figure # of combinations
280 C=1
290 FOR I=0 TO 6
300 C=C*LEN(LS(P(I)))
310 NEXT I
320 PRINT "of (name, address or whatever)"
330 INPUT LINE N$
340 PRINT "LINE UP WITH TOP OF PAGE AND HIT 'RETURN'."
350 INPUT LINE Z$
360 PRINT #0
370 PRINT #0,N$
380 PRINT #0,LEFT$(PS,3);"--";RIGHT$(PS,4);" makes ";C;" different 'words'."
390 PRINT #0:PRINT #0
400 FOR I=0 TO LEN(LS(P(0)))
410 FOR J=1 TO LEN(LS(P(1)))
420 FOR K=1 TO LEN(LS(P(2)))
430 FOR L=1 TO LEN(LS(P(3)))
440 FOR M=1 TO LEN(LS(P(4)))
450 FOR N=1 TO LEN(LS(P(5)))
460 FOR O=1 TO LEN(LS(P(6)))
470 PRINT #0,MID$(LS(P(0)),IO,1);MID$(LS(P(1)),J,1);MID$(LS(P(2)),K,1);
480 PRINT #0,MID$(LS(P(3)),L,1);MID$(LS(P(4)),M,1);MID$(LS(P(5)),N,1);
490 PRINT #0,MID$(LS(P(6)),O,1);SPC(3);
500 IF POS(I)>LL THEN PRINT #0
510 NEXT O
520 NEXT N
530 NEXT M
540 NEXT L
550 NEXT K
560 NEXT J
570 NEXT I
580 CLOSE O
590 END

```

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CIRCLE 169 ON READER SERVICE CARD

Self-Reproducing Program Revisited

Dennie Van Tassel

Implementation in Basic

It is unrealistic to try to write a Basic program Pb which can accept all possible program descriptions as input, if only because of storage limitations. However, we are only really interested in running Pb with its own description b as input; hence, we can dimension storage accordingly. Roughly speaking, Pb should read in a sequence of strings y describing a program, then print out the sequence twice, once in the form of data initialization to replace READ instructions in Py, and once as the program Py with its READ instructions deleted. The resulting sequence yy will correspond to a program which, on no input, simulates Py on input y.

The bootstrap program Pb in Listing 1 was written in Maxi-Basic and run on a Digital Group Z-80 Computer. The program reads 13 input strings, say S1, S2, ..., S13, and concatenates them into a string P\$, it then outputs a program containing the following sequence of strings:

(a) assignment statements which set a string variable P\$ to the concatenation of S1, S2, ..., S13;

(b) the input strings S1, S2, ..., S13 (i.e., the program that was read in as data), with line numbers added.

The program Pb is, of course,

```

10 REM THIS IS A SELF-REPRODUCING PROGRAM
20 DIM PB(88)
30 PB$=""
40 PB$=PB$+"THIS IS A SELF-REPRODUCING PROGRAM"
50 PB$=PB$+"(DIM PB(88))"
60 PB$=PB$+"(S$=CHR$(32)+CHR$(88)+CHR$(36))"
70 PB$=PB$+"(S$=CHR$(61)+CHR$(43)+CHR$(34))"
80 PB$=PB$+"(N$=13+L$)"
90 PB$=PB$+"PRINT 10;S$+PB$(L+1,24)"
100 PB$=PB$+"FOR I=1 TO N"
110 PB$=PB$+"PRINT 20;L$+PB$(L+1,24)"
120 PB$=PB$+"NEXT I"
130 PB$=PB$+"FOR I=3 TO N"
140 PB$=PB$+"PRINT 14;I+10;S$+PB$(L+1+I,L+I)"
150 PB$=PB$+"NEXT I"
160 S$=CHR$(32)+CHR$(88)+CHR$(36)
170 S$=CHR$(61)+CHR$(43)+CHR$(34)
180 N$=13+L$
190 PRINT 10;S$+PB$(L+1,24)
200 PRINT 20;S$+PB$(L+1,24)
210 FOR I=1 TO N
220 PRINT 20;L$+PB$(L+1+I,L+I)
230 NEXT I
240 FOR I=3 TO N
250 PRINT 14;I+10;S$+PB$(L+1+I,L+I)
260 NEXT I
270 NEXT I
280 REM
290 REM THIS IS A SELF-REPRODUCING PROGRAM
300 DIM PB(88)
310 PB$=""
320 PB$=PB$+"THIS IS A SELF-REPRODUCING PROGRAM"
330 PB$=PB$+"(DIM PB(88))"
340 PB$=PB$+"(S$=CHR$(32)+CHR$(88)+CHR$(36))"
350 PB$=PB$+"(S$=CHR$(61)+CHR$(43)+CHR$(34))"
360 PB$=PB$+"(N$=13+L$)"
370 PB$=PB$+"PRINT 10;S$+PB$(L+1,24)"
380 PB$=PB$+"PRINT 20;L$+PB$(L+1,24)"
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410 PB$=PB$+"NEXT I"
420 PB$=PB$+"FOR I=3 TO N"
430 PB$=PB$+"PRINT 14;I+10;S$+PB$(L+1+I,L+I)"
440 PB$=PB$+"NEXT I"
450 PB$=PB$+"FOR I=1 TO N"
460 PB$=PB$+"PRINT 20;L$+PB$(L+1,24)"
470 PB$=PB$+"NEXT I"
480 S$=CHR$(32)+CHR$(88)+CHR$(36)
490 S$=CHR$(61)+CHR$(43)+CHR$(34)
500 N$=13+L$
510 PRINT 10;S$+PB$(L+1,24)
520 PRINT 20;S$+PB$(L+1,24)
530 FOR I=1 TO N
540 PRINT 20;L$+PB$(L+1+I,L+I)
550 NEXT I
560 FOR I=3 TO N
570 PRINT 14;I+10;S$+PB$(L+1+I,L+I)
580 NEXT I
590 NEXT I
600 REM

```

Listing 3. The self-reproducing program with its output.

I received many solutions for this problem. For those of you that may have missed it in the Sep/Oct 1976 issue, here is the problem: Write a program that prints an exact copy of itself. No input statements are allowed.

Several people sent in solutions where they used the file the program was in or they created a file before hand, and then read the file. But this violated the rule that no input statements were allowed. Also there were several solutions sent in that required over a page of code.

Here are three good solutions, one in BASIC and two in FORTRAN. No COBOL solution was sent in, even though it is fairly easy in COBOL. It seems it should be possible to write a shorter BASIC version, but the solution is pretty good.

```

10 DATA "88:"DATA "CHR$(34)
20 DATA "FOR J=10 TO 100 STEP 10
30 DATA "READ AS
40 DATA "PRINT J$S$AS
50 DATA "IF J=90 THEN 170
60 DATA "NEXTRE
70 DATA "88:"
80 DATA "NEXT J
90 DATA "END
100 DATA "CHR$(34)
110 FOR J=10 TO 100 STEP 10
120 READ AS
130 PRINT J$S$AS
140 IF J=90 THEN 170
150 NEXTRE
160 R$=
170 NEXT J
180 END

```

Basic solution by Donald Bell, a student at California State University at Fullerton.

```

REAL=8F(6)/ABH(T*REAL=8F(6)/ABH*ABH,1H//TX*PRINT,F//TX*END)//
PRINT,F
END

```

Fortran solution by Mark Barnett at Stanford University.

```

WRITE(6,100)
CALL EXIT
100 FORMATT(77,12)WRITE(6,100)/77,9NCALL EXIT/
176,6H12(48H,769,2H)/,77,2(31H/76,6H12(48H,769,2H)/,77,2(31H/
1742,11H)/77,3HE90D,76,2(28H)742,11H)/,77,3HE90D,76,2(28H)777,3HE90D
END

```

Fortran solution by Armond O. Friend of Brookline, Mass., a Freshman at MIT

PRESS ON

Nothing in the world
can take the place
of persistence.

Talent will not;

Nothing is more common
than unsuccessful men
with talent.

Genius will not;

Unrewarded genius
is almost a proverb.

Education will not;

The world is full
of educated derelicts.

Persistence and determination alone
are omnipotent.

—Unknown

Self-Repro, cont'd...

independent of its data, and has 18 lines. The DATA for Pb is given in Listing 2. It consists of Pb with the following changes: the REM statement was modified, the READ loop was omitted to avoid having to delete it during execution, and the STOP statement was omitted (it was needed in Pb only because of a quirk in the way Maxi-Basic treats DATA containing the colon symbol:). Hence there are 13 input strings, as expected by Pb.

The main difficulty encountered in writing the program came from the fact that Maxi-Basic does not allow quotes inside quoted expressions. The program, however, requires instructions such as:

```
PRINT 30: "P$-P$+" + "QM" + P$(1,L) + "QM"
```

where QM denotes a quotation mark (to output an assignment instruction which concatenates a string P\$ to the value of a string function; this value must appear between quotes in the assignment statement). Since QM cannot be replaced inside the quotes by a quotation mark, this effect is achieved by replacing QM by CHR\$(34), a built-in function which returns the character whose ASCII code is 34 (namely, the quotation mark.) Since in addition the quoted

expression "P\$-P\$+" would appear within quotes in the DATA strings, it must be replaced by the concatenation of the CHR\$(34) values of the ASCII codes for P, \$, -, and + (80, 36, 61 and 43 respectively). CHR\$(32) is used to provide blanks. The output of the bootstrap program run with the given DATA is the self-reproducing program which appears, together with its output, in Listing 3.

Implementation in LISP

We include this section as propaganda for the use of the LISP language for symbolic manipulation. (For a description of the language, see BYTE, August 1979). It is much more straightforward to implement the general bootstrap function in LISP, for the following reasons:

- (1) LISP programs are in the form of LISP data, and
- (2) LISP was partly designed as a formalism for doing recursive function theory.

Writing the self-reproducing form suggested by our method requires only the basic LISP functions LIST and QUOTE. The bootstrap function B is defined by the lambda-expression displayed in Listing 4. If the argument given to B is a lambda-expression Y, the value B(Y) will be a form (YY),

```
(defun b (y)
  (lambda (x)
    (list
      (quote lambda)
      nil
      (list
        (quote quote)
        y))))
```

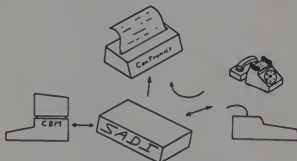
Listing 4. The bootstrap function

```
(defun b (y)
  (lambda (x)
    (list
      (quote lambda)
      nil
      (list
        (quote quote)
        y))))
```

Listing 5. The self-reproducing form

where YY is a lambda-expression for a function of no variables which applies the function Y to the argument Y. When B is given its own definition as argument (an easy way to do this is to CSET the atom B to the value of GET(B EXPR) and then to evaluate (B B)), the result is the form displayed in Listing 5. This is a self-reproducing LISP form, which evaluates to itself. □

PET TWO-WAY RS-232 and PARALLEL OUTPUT INTERFACE



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AIR TRAFFIC

In Air Traffic Controller you assume responsibility for the safe flow of

air traffic within a 15x25 mile area up to 5,000 feet in altitude. During your shift as a controller in charge of this airspace, 26 aircraft become active and under your control. Jets and prop planes have to be guided to and from the two airports, navigational beacons and ten entry/exit fixes. The aircraft enter the controller's airspace at various altitudes and headings whether or not you are ready.

Air Traffic Controller retains the basic realism of air traffic control. This program requires the same steady nerves under pressure and the same instant, almost instinctive, analyses of complex emergencies which are demanded of a professional air traffic controller. But "ATC" adds the excitement and well-defined goals of a game. This is just a simulation, and all passengers left in air traffic limbo by a panicked player will live to fly another day.

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CONTROLLER

The most obvious measure of difficulty of a game is the clock setting at the beginning. In a 99 minute game you will have time to go fix a sandwich between the appearance of two successive aircraft, while in the 16 minute game you may not have time to swallow before all of the aircraft have appeared.

No two games, even at the same clock setting, are ever alike. As controller, you must cope with the unique requirements of each aircraft. The game will end if you commit a "boundary error," that is, if an aircraft fails to leave your area at the proper altitude and exit fix...causing an unpleasant surprise for the controller next door. The game also ends if you fail to leave a comfortable margin of safety be-

tween the aircraft as they whiz past each other in cases of excessive delay, fuel supply considerations will become invested with a particular sense of urgency.

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Your local retail store should carry Creative Computing Software. If your favorite retailer does not carry the software you need, have him call in your order to (800) 631-8112. Or you can order directly from Creative Computing. Write to Creative Computing Software, P.O. Box 789-M, Morristown, NJ 07960. Air Traffic Controller is now available for the 16K TRS-80 (3006), for the 16K Apple II and Apple II Plus (4008), the 8K Sorcerer (5008) and for the 4K Sol-20 (8001). All are on cassette for \$9.95. Include \$1.00 for postage and handling. For faster service, call in your bank card order toll free on our order hotline, (800) 631-8112.

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CIRCLE 350 ON READER SERVICE CARD

CHORD

Richard K. Lindgren

Most music-related computer programs use the computer to either compose or play music. Another practical use is in aiding the musician's or computer hobbyist's own skills in composing or transcribing music.

Often, when learning or composing a song using a piano or guitar, the musician will know only two or three notes of each chord. There may be several possible chords which have the known notes in common. This program will tell the user what those chords are, and what the unknown notes would be for each possible chord. The musician can then select the appropriate chord from the choices given.

There may be several possible chords which have the known notes in common. This program will tell the user what those chords are, and what the unknown notes would be for each possible chord.

The chords are selected from ten of the most common in all twelve keys. The program will automatically respond in either flats or sharps, depending on which mode the user keys in the input. If the tonic note of the chord is known, the program will limit its search to that key only. By inputting a question mark as the first note, all twelve keys will be searched.

The program is written in Data General "Eclipse" Basic. The problems in converting to other systems, however, should be limited to variations in the use of character strings. Additional chords may be added by increasing the size of arrays C and CS, changing the chord count in line 1360, and adding additional chord data. The numbers representing each chord are simply the relative intervals of the half-tones, numbered 1 through 12.

Richard K. Lindgren, 15055 Salem, Redford, MI 48239.

A Program For Computer-Aided Music Transcription



BRUN

INSTRUCTIONS - Y OR N?

? Y

THIS PROGRAM FINDS CHORDS THAT CONTAIN NOTES INPUT BY THE USER. ENTER ONE OR MORE NOTES OF A CHORD AS THEY ARE REQUESTED, FOLLOWED BY 'GO' WHEN READY TO SEARCH FOR CHORDS. SHARPS SHOULD BE INDICATED BY '#' (E.G. C#), FLATS BY AN 'F' (E.G. D#). THE TONIC NOTE SHOULD BE INPUT FIRST. IF UNKNOWN, ENTER A '?' AS THE FIRST NOTE.

INPUT NOTE OR 'GO'

? A

INPUT NOTE OR 'GO'

? E

INPUT NOTE OR 'GO'

? C#

INPUT NOTE OR 'GO'

? GO

A MAJOR
A SEVENTH
A MAJOR 7TH
A SIXTH
A NINTH
A ? SUS 4

A C# E
A C# E G
A C# E G#
A C# E F#
A C# E G B
A C# E G D

INPUT NOTE OR 'GO'

? F

INPUT NOTE OR 'GO'

? B#

INPUT NOTE OR 'GO'

? D#

INPUT NOTE OR 'GO'

? F

INPUT NOTE OR 'GO'

? EF

EF NINTH

EF G BF DF F

INPUT NOTE OR 'GO'

? EF

INPUT NOTE OR 'GO'

? GF

INPUT NOTE OR 'GO'

? BF

INPUT NOTE OR 'GO'

? C

INPUT NOTE OR 'GO'

? GO

NO CHORDS FOUND

INPUT NOTE OR 'GO'

? GO

STOP AT 1470

8

```

0010 REM PROGRAM TO FIND CHORD NAMES
0020 REM WRITTEN BY R.K.LINOGREN
0030 REM IN DATA GENERAL 8481C 1-30-80
0040 DIM N$[36],M$(36),C[10],S,C$(100),Q$(15),Q[5],T$(11)
0050 REM DEFINE FUNCTIONS FOR FINDING START CHARACTER IN NOTE NAMES
0060 DEF FNA(P)=P-1+3+1
0070 REM SAME FOR CHORD NAMES
0080 DEF FNB(P)=(P-1)+10+1
0090 REM READ HALF-TONE NAMES, SHARPS, THEN FLAT EQUIVALENTS
0100 READ N$
0110 READ M$
0120 REM READ NUMBER OF CHORDS, CHORD NAMES, THEN INTERVALS
0130 READ A
0140 FOR I=1 TO A
0150 LET S=FNB(I)
0160 READ C$(S,3+9)
0170 FOR J=1 TO 5
0180 READ C[I],J1
0190 NEXT J
0200 NEXT I
0210 PRINT "INSTRUCTIONS - Y OR N?"
0220 INPUT Y$
0230 IF Y$="N" THEN GOTO 0320
0240 PRINT "THIS PROGRAM FINDS CHORDS THAT CONTAIN NOTES INPUT BY THE"
0250 PRINT "USER. ENTER ONE OR MORE NOTES OF A CHORD AS THEY ARE"
0260 PRINT "REQUESTED, FOLLOWED BY 'GO' WHEN READY TO SEARCH FOR CHORDS."
0270 PRINT "SHARPS SHOULD BE INDICATED BY '#' (E.G. C#), FLATS BY AN 'F'"
0280 PRINT "(E.G. OF). THE TONIC NOTE SHOULD BE INPUT FIRST. IF"
0290 PRINT "UNKNOWN, ENTER A '?' AS THE FIRST NOTE."
0300 REM
0310 REM READ IN NOTES
0320 LET I=0
0330 LET F=0
0340 LET F#0
0350 LET Q#=""
0360 PRINT
0370 LET I=I+1
0380 IF I=5 THEN GOTO 0430
0390 PRINT "INPUT NOTE OR 'GO'"
0400 LET S=FNA(I)
0410 INPUT Q$(S,3+11)
0420 IF Q$(S,3+11) <> "GO" THEN GOTO 0370
0430 LET I=I-1
0440 IF I=0 THEN GOTO 1470
0450 PRINT
0460 REM CONVERT NOTES TO NUMERIC 1-12
0470 FOR J=1 TO I
0480 GOSUB 1050
0490 REM BIAS TO 1ST NOTE
0500 IF J=1 THEN GOTO 0530
0510 LET Q$(J,3+11)=1
0520 GOTO 0550
0530 LET Q[J]=Q[J]-8
0540 IF Q[J]<1 THEN LET Q[J]=Q[J]+12
0550 NEXT J
0560 IF Q[1]=0 THEN GOTO 0600
0570 REM RUN WITH 1ST NOTE AS TONIC
0580 GOSUB 0800
0590 GOTO 0760
0600 REM
0610 REM UNKNOWN TONIC, TRY THEM ALL
0620 LET Q[1]=1
0630 IF I=2 THEN GOTO 0720
0640 FOR H=1 TO 12
0650 REM GET TONIC NOTE
0660 LET Q#=""
0670 LET E=1
0680 LET S#=""
0690 GOSUB 1240
0700 FOR D=2 TO I
0710 LET Q[D]=Q[D]-1
0720 IF Q[D]<1 THEN LET Q[D]=Q[D]+12
0730 NEXT D
0740 GOSUB 0800
0750 NEXT H
0760 IF F#1 THEN GOTO 0320
0770 PRINT "NO CHORDS FOUND"
0780 GOTO 0320
0790 REM SUBROUTINE TO SEARCH CHORD ARRAYS
0800 FOR J#1 TO A
0810 LET G#1
0820 FOR K#1 TO 5
0830 FOR L#2 TO I
0840 REM COUNT THE MATCHED NOTES
0850 IF Q[I]=C[J],K THEN LET G#G+1
0860 NEXT L
0870 NEXT K
0880 IF G#1 THEN GOTO 1000
0890 REM ALL NOTES MATCH, PRINT THIS CHORD
0900 FOR E#1 TO 5

```

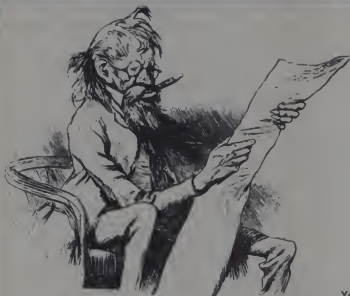


```

0910 LET D#C[J,E]
0920 IF Q#0 THEN GOTO 0950
0930 LET D#D#
0940 IF D#12 THEN LET Q#D-12
0950 GOSUB 1240
0960 NEXT E
0970 LET S#FNB(J1)
0980 PRINT Q$(1,2),C$(S,8+9),Q$
0990 LET F#1
1000 NEXT J
1010 RETURN
1020 REM
1030 REM SUBROUTINE TO CONVERT TO NUMERIC 1-12
1040 REM QUESTION MARK IS 0
1050 LET S#FNA(J1)
1060 IF Q$(S,3+11) <> "?" THEN GOTO 1090
1070 LET Q[J]=0
1080 GOTO 1200
1090 FOR K#1 TO 12
1100 LET T#FNA(K)
1110 IF Q$(S,3+11)=NS[T,T+1] THEN GOTO 1190
1120 IF Q$(S,3+11) <> NS[T,T+1] THEN GOTO 1160
1130 REM READ FROM FLAT ARRAY
1140 LET F#1
1150 GOTO 1190
1160 NEXT K
1170 PRINT "INVALID NOTE=",Q$(S,3+11)
1180 GOTO 0320
1190 LET Q[J]=K
1200 RETURN
1210 REM
1220 REM SUBROUTINE TO GET NOTE NAME, GIVEN NUMBER
1230 REM F#0, READ SHARPS; F#1, READ FLATS
1240 LET S#FNA(E)
1250 IF Q#0 THEN GOTO 1280
1260 LET Q$(S,3+11)= " "
1270 GOTO 1330
1280 LET T#FNA(O)
1290 IF F#1 THEN GOTO 1320
1300 LET Q$(S,3+11)=NS[T,T+1]
1310 GOTO 1330
1320 LET Q$(S,3+11)=NS[T,T+1]
1330 RETURN
1340 DATA "A A# B C C# D D# E F F# G G# "
1350 DATA "A B B# C C# D D# E F F# G G# "
1360 DATA 10
1370 DATA "MAJOR",1,5,8,0,0
1380 DATA "MINOR",1,4,8,0,0
1390 DATA "SEVENTH",1,5,8,11,0
1400 DATA "MINOR 7TH",1,4,8,11,0
1410 DATA "MAJOR 7TH",1,5,8,12,0
1420 DATA "DIMINISHED",1,4,7,10,0
1430 DATA "AUGMENTED",1,5,9,0,0
1440 DATA "8TH",1,5,8,10,0
1450 DATA "9TH",1,5,8,11,3
1460 DATA "7# SUS 4",1,5,8,11,6
1470 STOP
1480 END

```

puzzles & problems



Merlin's Uncle Ezra has been working for days trying to find the solution to the following word puzzle sent in by Richard Reed of Broken Arrow, Oklahoma. It's a very good puzzle and Merlin is sending along a copy of "Merlin's Puzzler #1" to Mr. Reed. The object of the puzzle is to complete a paragraph using ten common English words. What makes it difficult is the way in which the words are formed. You start out with a one letter word and by adding only one letter to it make the second word. The third thru tenth words are formed in the same way by adding one letter to the previous word. Letters may be rearranged, but none may be dropped. Here is the Paragraph:

"... think is a strange custom," said the man with the black _____, "and a peculiar _____, but a fact that when we _____ a body, we _____ a _____ memory of it. The _____ of laws concerning _____ is proof of its _____."

Happy Adding

You'll be as happy as the little boy pictured here if you can discern the answer to the following puzzle submitted by our publisher's father, Mr. Howard Ahl of Palm Bay, Florida. A copy of "Merlin's Puzzler 2" is winging South.

If the digits 1 2 5 7 8 7 5 2 1 = 14 and
the digits 9 8 7 6 5 6 7 8 9 = 9 what do
the digits 1 2 3 4 5 6 7 8 9 equal?



The Egg And The Cannon Ball

Exhibiting an egg and a cannon ball (you can use a basketball), you hold forth learnedly on the extraordinary strength of a perfect arch, and, still more, of a perfect dome, remarking that few people know how strong even the shell of an egg is, if it is placed in a proper position. In proof of your assertion, you undertake to place the egg, without covering it in any way, in such a position that no one present can break it with the cannon ball. How can that be? (From "Puzzles Old and New" by Professor Hoffmann as reprinted in "Merlin's Puzzler 2").



"As I was going to St. Ives, I met a man with seven wives. Each wife had seven sacks. Each sack had seven cats. Each cat had seven kits: Kits, cats, sacks, and wives. How many were there going to St. Ives?"

Innkeeper, a small libation, if you please. Thaumaturgical recitations dealing with puzzles leave me with an inordinate thirst!

Mr. Fields has presented us with a pretty problem. Just how many are there going to St. Ives? He informs us that this is a very old English stumper. Innkeeper, another round while we work on this one. (From "Merlin's Puzzler 3")

Far A Fields

Answers on page 192.



The Old Dictionary Quiz

While browsing in a used book store I came upon an interesting old copy of a Funk and Wagnall's Dictionary from 1915. Following is a list of 14 words that I have selected from it. Can you match 7 of them to the pictures I've selected from the book? (See pictures along the left side of this page)

The words are: (A) Stereoscope, (B) Char-a-banc, (C) Xat, (D) Catalo, (E) Juggernaut, (F) Adjutant, (G) Bittern, (H) Peccary, (I) Uhlan, (J) Parbuckle, (K) Sphygmograph, (L) Fiacre, (M) Cowl, (N) Roentgen Rays

All Work And No Play

Here's a new change-the-word puzzle from Mr. Mark Kantrowitz of Brookline, Mass. He challenges our readers to change the word **PLAY** into the word **WORK** in eight steps. During each step the puzzler must change one letter in the previous word so that a new word is formed. (For example, you can change the word **WARM** into the word **COLD** in four steps: **WARM**, **WARD**, **WORD**, **CORD**, **COLD**). In Mr. Kantrowitz's solution one of the words formed is an abbreviation. Mr. Kantrowitz has requested a copy of "Merlin's Puzzler 1" which is on the way.

A Puzzling Inscription

The following interesting inscription is said to be found in the chancel of a small church in Wales, just over the Ten Commandments. The addition of a single letter, repeated at various intervals, renders it not only intelligible, but appropriate to the situation:

PRSVRYPRFCTMN
VRKPTHSPRCPTMN

What is the missing letter?

Don't Be A Square

To solve this puzzle you will first have to draw three Greek crosses on a piece of light cardboard. (A Greek cross is formed using five squares). Then, cut each cross into several pieces as indicated by the lines in our illustration. Cross A is cut into eight pieces and crosses B and C are each cut into four pieces. Now, your problem is to rearrange the pieces in each cross to form a perfect square.



I hope that these eight problems from Merlin provided entertainment for our readers. If you have a favorite puzzle why not share it with the rest of us? If Merlin uses it in his column he will send you a copy of one of his "Merlin's Puzzler" books, a gift that is always welcome.

Your Editor, Charles Barry Townsend.

The Secret Life of Paragraphs



"It's no fun being a paragraph. Your whole job is to keep out of sight. If you do your work well, people just skim through you, because they pick up your meaning with no effort. And what do you get for your trouble? A few periods and an exclamation point — if you're lucky.

"Oh, but if you slip up! Then they notice. 'You ugly, misshapen thing,' they say. 'You affront to reason! What are you doing on page 14 when you belong on page 15? And where did you pick up all that extraneous information? You should be ashamed of yourself! Why, if I were you, I'd go hide in the Index.'

"It's not my fault," I tell them. "My writer had gone three pages without a paragraph and figured it was time for a break. He's not too good with paragraphs. He doesn't understand that a paragraph should have some coherence, that it should develop a theme in a definite direction. He just lumped together some unrelated sentences and called them a paragraph. Can I help it if I was born ugly?"

"I try to educate my writer. 'Organize your writing into a sequence of topics,' I tell him. 'Each topic is a paragraph, and everything in that paragraph relates to that topic. And the topics go *bang bang bang*... one right after the other. When you come to a topic that doesn't go *bang*, because it's outside the logical flow you've established, then you're changing directions, and need a transition.'

"What's a transition?" he asks. Imagine! Asking one of your own paragraphs what a transition is! This guy's poetic license should be revoked.

"A transition," I tell him, "is a notice to the reader that the flow is somehow changing. It's also a statement of how the new direction is logically linked to the old one. For

example, the word *But* at the beginning of a paragraph is a warning to the reader that you're shifting gears. A summary of what you've said, and an indication of the general topic on which you're about to embark, is a transition. Try writing very short sentences, or even sentence fragments, at turning points — you'll wake up the reader.

"Always let the reader know where he stands," I add authoritatively.

"Anything else?" my writer asks.

"Yeah," I say. "Verbs. For Gods sake give us some verbs to work with. Active, assertive, specific verbs. There is a vague, general assertion. Can you be more specific? *May* be is also uninformative, unless you explain the reason for your uncertainty. *It is said* that and *it is known* that are lazy. Who says? Who knows? Can you quote them?"

"You're pretty knowledgeable, for a paragraph," my writer says.

"A cousin of mine works for the encyclopedia," I say. "And another thing. Variety is the spice of life. Use different kinds of punctuation: question marks, colons, semicolons, dashes, quotation marks. Use your imagination. Do anything you can to enliven your message without distracting from it. Most writing is deadly dull.

"But the most important thing of all is to be brief. Make every word count. My cousin told me a quip from a 19th century preacher and writer named Sydney Smith. It runs: 'In composing, as a general rule, run your pen through every other word you have written; you have no idea what vigor it will give your style.'"

"Thanks," says my writer. "I'll keep it in mind."

"He'll never learn."

The authorship of this column rotates, and this is the last in a series of three by yours truly. So it's a good time to bring up an important point. One

does not "write" in the abstract, one communicates specific things to specific people. There is no such thing as "good writing"; there is only good communication in a particular place and time. *Never forget the reader.* It is his or her needs that dictate the proper style of writing.

For example, editors of micro-computer magazines usually ask writers to limit their use of technical terms to the bare minimum (though the minimum is sometimes a mouthful). There's a reason for this: the readers have varying amounts of technical knowledge, but editors want every reader to learn something from every article. A presentation appropriate for an engineering seminar is probably out of place here, because it would be over the heads of neophytes.

Write about your specialty, whether it's circuit design, interpreter oddities, or computers in education. But if you're writing for the general public, try to write coherently. See whether there is some way to make your message clear to the uninitiated.

Conversely, don't write a technical paper as if it were a magazine article. Your readers are going to study it, not glance at it to see if it's within their comprehension. Graduates of "good writing" classes sometimes object that their bosses want ponderous, turgid reports, not the lighter style that is usually taught in the classes. Fine. Write for your readers. All you want is that they understand you.

In *The Elements of Style*, E. B. White reminisces about the stylistic philosophy of the memorable William Strunk, Jr. "Will felt that the reader was in serious trouble most of the time, a man floundering in a swamp, and that it was the duty of anyone attempting to write English to drain this swamp quickly and get his man up on dry ground, or at least throw him a rope."

I hope that my suggestions will help you keep to the high ground. □

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THE CORRESPONDENT: At last an economical alternative to the higher priced text editors now available! THE CORRESPONDENT not only supports upper/lower case, but features character & line insert & delete functions. Output can be from 40 to 80 columns, with 4-directional scrolling to allow you to see exactly what will be output to the printer. It's very fast FIND routine makes it ideal as a free-form database for storing notes, phone lists, or anything where report generation is not essential. It will also access random or sequential text files — useful not only for the editing ability, but to examine & transfer data files, or for building your own EXEC files. routines are even included for putting the bidirectional scrolling in your own programs!

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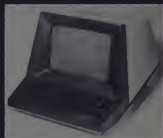


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CIRCLE 149 ON READER SERVICE CARD



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Harold L. Novick

The *Forum* appeared last in the May issue because this author missed his deadline for the June issue. Be thankful! You may never get another such break. Thus the promise to answer the argument by the Patent and Trademark Office (PTO) on why computer programs should not be patentable was not kept on time. *Mea Culpa!* However, read on, because here it comes.

Many critics, groups, organizations, corporations, and, yes, even governmental agencies have questioned and criticized the position that new and unobvious computer programs should be patentable subject matter. Some have even predicted that chaos would surely result if they are patentable. Do not be confused. All inventions, even software, in order to be patentable, must always be novel and unobvious. These people are saying that even given a new and unobvious computer program, it is not patentable because it is not patentable subject matter. It is hoped that they are wrong.

The government's position is essentially that all computer programs are algorithms, and algorithms, according to their interpretation of decisions of the Supreme Court of the United States, have been held to be unpatentable subject matter. This position, if carried to its logical extreme, would preempt the patentability of every novel and unobvious process or method ever devised. In a recent legal brief to the Supreme Court of the United States (*Diamond, Comm'r of Patents and Trademarks v. Bradley*,

Petition for a Writ of Certiorari, Case No. 79-855), the government defines an algorithm very broadly as follows:

1. A fixed step-by-step procedure for accomplishing a given result; usually a simplified procedure for solving a complex problem, also a full statement of a finite number of steps.
2. A defined process or set of rules that leads and assures development of a desired output from a given input. A sequence of formulas and/or algebraic logical steps to calculate or determine a given task; processing rules.¹

The PTO, if it had its way, would hold all "algorithms" to be unpatentable subject matter. Query: What process, be it a method for brewing beer, curing cancer, building a house, or manufacturing a chemical composition, is not a "fixed step-by-step procedure for accomplishing a given result"? Thus, by this definition of an algorithm, all processes would be unpatentable.

A procedure to determine whether a claimed invention that encompasses an algorithm falls within a class of patentable subject matter was set forth in the most recent Supreme Court case, *Parker, Acting Commissioner of Patents v. Flook*, 437 US 584, 198 USPO 193 (1978), (*Flook*). The Court stated that if the claim (which is a concise written statement in a patent application of what the applicant regards as his or her invention) contains a mathematical formula, the formula must be considered to be old and the claim is not patentable unless there is some other inventive concept in it.

One commentator, using this procedure, applied the logical meaning of

the government's definition of an algorithm to a slide rule, a machine and not a process. He states as follows:

The PTO continues to allow patents on slide rules based on the type of mathematical algorithm performed thereby, while relying on *Benson* and *Flook* to deny patent protection to computer programs and methods of calculation solely suitable for execution by electronic data processing equipment. These positions are inconsistent and irreconcilable. There is no material difference between a mechanical calculator and an electrical or electronic one to justify such variance in treatment under the patent laws.²

Then he concludes:

"The inconsistency between the PTO practice and the standards set forth in *Flook* indicates that the test for patentability of inventions embodying principles of nature is too restrictive a standard to be applied to innovations involving an algorithm."³

The PTO has a Board of Appeals that is the first stage in the process of appealing the Patent Examiner's refusal to grant a patent. This Board of Appeals, perhaps recognizing the absurdity of using a broadly defined algorithm to determine patentability, has attempted to limit its position to mathematical algorithms. However, not wanting to grant patents for computer programs, the Board tried to suggest that all computer programs are mathematical algorithms and thus they still are not patentable. Their reasoning is as follows:

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[B]ecause a digital computer operates mathematically, employing numerical quantities according to at least one radix, appellants' claims [directed to a computer system for generating architectural specification and project control instructions] are directed to an algorithm — to the solution of a problem, which problem is stated in mathematical terms... the solution of the problem being effected mathematically by the computer. *In re Phillips*, 203 USPO 971, 975 (CCPA 1979).

The Board also stated that all digital computers operate mathematically in solving problems "even though, to the user, the problem does not appear to be in mathematical form." The Court of Customs and Patent Appeals (CCPA), a reviewing court to which adverse Board decisions can be appealed, gave short shrift to the Board's opinion. The Board's position, in essence, is that because a digital computer "operates mathematically, employing numerical quantities according to at least one radix, all claims directed to computer-related inventions are directed to an algorithm [within the Supreme Court's meaning of that term]. We note that the radix merely defines a system of number representation and does not arithmetically calculate the solution to a mathematical problem." *In re Phillips*, supra, at 975. The Board clearly erred in finding [that the claim recites a procedure for solving a mathematical problem]. *In re Phillips*, supra, at 975.

Obviously, the PTO Board of Appeals is trying to prevent the patenting of all computer programs and the CCPA is trying to make sense of all previous Supreme Court pronouncements. The difficulty is that the Supreme Court only wants to award patents for those inventions which promote the useful arts and does not want to grant them for inventions that would hinder this promotion. Therefore, the Supreme Court refuses to allow the basic tools of scientific and technological work, such as phenomena of nature, mental processes, and abstract intellectual concepts to be patentable subject matter. Not being a scientific body, not being trained in the physical sciences and engineering, the Supreme Court often writes inarticulate opinions when it tries to express this view. Knowing this, the PTO and the Department of Justice appeal the patentability of esoteric inventions to the Supreme Court so that no matter what the Court holds, there will be something in the

decision which they can use to advance their position.

What does this mean to the software community? Patents for software will be expensive, and the fight could go to the Supreme Court. There will be long delays before protection is obtained (a patent can be used to stop others from making, using, or selling the patented invention only after it has been granted). Because a patent application is secret only before the PTO, your computer program will become known if you appeal the PTO's probable decision of unpatentability.

However, an attempt should still be made to patent certain types of computer programs. If the program does not solve a mathematical algorithm, is very valuable, has a long life time, and can be discovered through use, then the best protection may be from patents. More about this cannot be written at this time because, once again, the Supreme Court has agreed to review two cases involving the question of the patentability of new and unobvious "computer programs." These decisions could alter all of the rules of the game.

The first case is the above mentioned *Diamond v. Bradley*. The invention involves an improved method of using firmware for changing the data in scratchpad registers of some high performance computers. The CCPA described the invention as follows:

Specifically, the invention relates to altering or repositioning information in the computer's system base. The system base of a computer is a fixed area in main memory which acts as the root for all information structures in the computer. In high performance computer systems, it is very advantageous to store portions of the system base in "scratchpad" registers located in the central processing unit (CPU) of the computer rather than in main memory. This greatly enhances the speed of operation of the computer because the access time (the time it takes to retrieve information from a given place) associated with the scratchpad registers is less than that associated with main memory. A problem arises, however, because a programmer may wish to change the positions or content of information in the system base which happens to be located in the scratchpad registers. These registers are "invisible" to the programmer since, unlike main memory, they cannot be accessed by software (computer programs). Prior art sys-

tems altered the system base information resident in the scratchpad registers by either reinitializing the system base (completely reloading the system base containing the new information), a process which consumes a considerable amount of time, or by using software which takes advantage of the model-dependent properties of the particular computer. The latter method has the undesirable effect of resorting to reliance on model-dependent software, which is unacceptable to some computer users.

Appellants' invention enables system base information to be altered without having to resort to these techniques and their accompanying drawbacks. They accomplish their result by employing a "firmware" module, consisting of hardware elements permanently programmed with a microcode, which directs the data transfers, between the scratchpad registers and the system base located in main memory, which are necessary to effect the alteration.

The invention in the other case relates to a direct digital control method of operating rubber molding presses. A programmed digital computer is provided with a data base that includes natural logarithm conversation data, an activation energy constant based on the compound being molded, a constant based on the geometry of the molding press, the elapsed time since the press was closed, and the temperature of the mold. The computer then repetitively calculates the required cure time based on a well known mathematical equation (the Arrhenius equation). When the cure time equals the elapsed time, the computer provides a signal to open the press.

The *Bradley* firmware invention clearly does not involve a mathematical algorithm while the *Diehr* rubber molding method clearly does. It will be interesting to see what the Supreme Court does.

Next month this column will return to software copyrights and will be written by a guest author, Martha R. Gore of Tucson, Arizona. □

1 C. Sipple & C. Sipple, *Computer Dictionary and Handbook* 23 (2nd ed. 1972).

2 Gorenstein, "The Dual Standard of Patentability: A New Look at the Computer Issue," 62 JPOS 96, 103 (Feb. 1980).

3 Gorenstein, supra, at 106 and 107.

4 *In re Bradley*, 202 USPO 480, 482 (CCPA 1979), cert. granted sub nom. *Diamond v. Bradley*.

5 *In re Diehr*, 203 USPO 44 (CCPA 1979), cert. granted sub nom. *Diamond v. Diehr*.

Intelligent Computer Games



David Levy

Correspondence is welcome. Letters with interesting questions and ideas will be used in the column along with a response. No personal replies can be made. Send to: David Levy, 104 Hamilton Terrace, London NW8 9UP, England

All of the games that have been discussed so far in this series have been full information games, that is to say, each player knows exactly what forces are at his opponent's disposal and therefore what moves his opponent may make. This month we shall consider some of the problems posed by games in which this information is not readily available, and perhaps the best example of this type of game is a card game. When playing a game of cards you usually know which cards you have been dealt, but normally you will not see the cards that have been dealt to your opponent(s). You may be able to deduce certain things about an opponent's card holding from the way in which he bids or plays, but it is unlikely that you will know exactly what he holds until very near the end of the hand. Decisions made in this sort of environment must be made on a probabilistic basis, in other words, you play with the odds and hope for the best. If you have calculated the odds correctly you will win more often than you lose.

Shuffling

Before proceeding to the main point of this month's article I should perhaps interpose a brief section on how to shuffle the cards in your program. The simplest method that

creates a randomly sorted deck is as follows. Starting with the deck in any order you wish (even perfectly sorted), interchange the first card in the deck with the R th card, where R is a pseudo-randomly chosen integer on the range 1 to n (n is the total number of cards in the deck). Then interchange the second card with another randomly chosen card, then the third, and so on to the end of the pack. The manner in which you generate your random numbers is of some consequence — I would recommend that while developing your program you use one of the seeding methods in which the $i+1$ -th random number is generated from the i -th number, and the series is started with a "seed" which may be chosen by the user. This approach has the advantage that if you spot a bug in your program you can recreate the hand simply by starting with the same seed. Once your program is debugged you may use the computer's internal clock to supply the seed, for example, by using the time elapsed between the pressing of two keys.

One seeded random number generator which will suffice is:

$$R_i = a^i \times \text{seed} \pmod{m}$$

where R_i = i -th pseudo-random number

$$a = 8t \pm 3 \text{ (for any positive integer } t)$$

$$m = 2^b \text{ where } b \text{ is the number of bits per word in your computer}$$

Deducing Information from the Play of the Cards

For the purpose of creating a simple example I have invented the following card game. The game is

played by three players who are each dealt 17 cards at the start of a hand. The 52nd card in the deck is turned face up and that suit is trumps. Starting with the player on the dealer's left, the player leads a card and the other players must follow suit if they can, or they may trump if it wish (provided that they are unable to follow suit). The player who wins one trick leads to the next, and the player who wins most tricks wins the hand.

Let us assume that we are dealt the following hand:

SPODES (trumps): A K Q J
HEARTS: 10 9 8 7 6
DIAMONDS: K 10 9 8 7 6 5 4 3 2
CLUBS: J 6 5 4 3 2

and that the 7 of spades is the card turned up. It is our turn to lead first.

At the start of the hand we know absolutely nothing about which cards our opponents hold, except for the fact that between them they hold all 34 of the unseen cards. But we do not have any indication as to how these 34 cards are distributed between the unseen hands, so the probability of each of the cards being in a particular hand is 0.5. We can therefore begin to construct, for each of our opponents (Bill and John) probability estimates for each card in the deck. At the start of the hand the estimates for each of them will be as follows:

	A	K	Q	J	10	9	8	7	6	5	4	3	2
SPODES:	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
HEARTS:	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
DIAMONDS:	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
CLUBS:	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Assume that we lead the 4 of spades, and that the next player (Bill) plays the 9 of spades and the third player (John) takes the trick with the Q. What have we learned about the

Games, cont'd...

probabilities of the other cards, if anything?

Before answering this question I must explain an important theorem from Probability Theory, called Bayes' theorem.

Bayes' Theorem

Let us suppose that there are two bags, each containing five balls. Bag A contains 1 white and 4 black balls. Bag B contains 3 white and 2 black balls. I take a ball at random from one of the bags, and the ball is white. What is the probability that I took the ball from bag A?

The probability that a ball selected at random from bag A will be white is $1/5$.

The probability that a ball selected at random from bag B will be white is $3/5$.

Bayes' theorem shows that the probability that a randomly selected white ball actually came from

$$\text{bag A} = \frac{1/5}{(1/5 + 3/5)} = 1/4.$$

The reader will be able to generalize from this example, and the application to our game of cards will soon become apparent.

What have we Learned?

Let us now return to the question of what, if anything, we have learned about Bill and John's hands from the cards they played to trick one. We probably cannot say very much at all about Bill's hand at the moment, but we already know something about John's cards.

John took the first trick with the Q of spades. The A and K are in our own hand and so the only cards that John could possibly have used to take the trick were the Q, J and 10. If John had held the Q and 10 but been missing the J, he would have played the 10, so from the fact that he played the Q we know that his original spade holding included:

Q, J and 10 or Q and J or Q (without J or 10)

Now we can use the tables of probabilities for the individual cards to determine the *a priori* probability that John held each of these three holdings:

Probability that he held the Q, J and 10 = $0.5 \times 0.5 \times 0.5 = 0.125$

Probability that he held the Q and J but not the 10 = $0.5 \times 0.5 \times 0.5 = 0.125$

(Note that since the probability of his holding the 10 is 0.5, the probability of his not holding it is $1 - 0.5 = 0.5$)

Probability that he held the Q but not the J or 10 = $0.5 \times 0.5 \times 0.5 = 0.125$

And from Bayes theorem we can show that the probability that the Q came from each of these three holdings is:

$$\begin{aligned} \text{Q,J,10: } & 0.125 / (0.125 + 0.125 + 0.125) = 1/3 \\ \text{Q,J: } & 0.125 / (0.125 + 0.125 + 0.125) = 1/3 \\ \text{Q: } & 0.125 / (0.125 + 0.125 + 0.125) = 1/3 \end{aligned}$$

Note that had the calculations been performed later in the hand, when the probabilities were not all equal (0.5), the final values would not all have been $1/3$.

From these last calculations we can see that the probability that John holds the 10 of spades is $1/3$ (in which case he also holds the J), and the probability that he holds the J is $2/3$. We can therefore adjust the probabilities for the individual cards in John's hand as follows:

For the 10 of spades:

$$\text{probability} = 0.333$$

For the J of spades:

$$\text{probability} = 0.667$$

For all other unseen cards the probabilities are equal, and these are:

$$\frac{16 - 0.333 - 0.667}{32 - 1 - 1} = \frac{15}{30} = 0.5$$

since there are 16 unseen cards in John's hand, and 32 unseen cards in total (the probabilities of the J and 10 of spades being in John's hand are subtracted from the number of cards in his hand, and one is subtracted for each of them from the total number of unseen cards).

If the probability of the J of spades being in John's hand is 0.667, then the probability of it being in Bill's hand is 0.333, and by the same argument the probability of Bill holding the 10 of spades is 0.667. So we have been able to make some adjustments in the probabilities simply on the basis of John having played the Q of spades at trick one. We can also make note of the fact that if John ever shows the 10 of spades, we will know that he holds the J.

At trick two, John must lead because he won trick one. He leads the A of hearts, we play the 5, and Bill trumps with the 8 of spades. What have we learned from trick two? First of all, Bill would obviously use his lowest trump or one of his lowest contiguous group of trumps. The 7 was the original face up card, we played the 4 on trick one and Bill played the 9. We hold the 2 of spades and so Bill's 8 of spades must have been played from one of the following holdings:

3,10,8,6,5,3.

J,10,8,6,5:

J,10,8,6:

J,10,8:

10,8,6,5,3:

10,8,6,5:

10,8,6:

10,8:

8,6,5,3:

8,6,5:

8,6:

8:

and by using Bayes' theorem we can determine the probabilities of each of the above cards being in Bill's hand, and from these probability estimates we can determine estimates for the cards being in John's hand. We can also adjust the probabilities for all the hearts: those which are not in our own hand must all be in John's hand.

Deducing Information from Bidding

In many card games there is a bidding phase between the deal and the play of the cards. The best known of such games is Bridge, but the popular German game of Skat is another widespread example (it is said that Skat can be played by more than 50% of the entire population of Germany). Since each bid has a meaning, it should be possible for the card playing program to learn something about its opponents' hands from the way they bid, and it can then adjust its probability estimates for each card in their hand. How this is done will obviously vary from one game to another. Let us take a brief look at bridge, to see how we might modify the probability estimates of the unseen cards in the light of the bidding.

We are sitting South and hold 10 high card points. We look at the 13 cards in our hand and assign a probability of $1/3$ to each of the remaining 39 cards in each of the other three hands. West opens the bidding and bids one spade, indicating that he has a stronger than average hand and that spades is his best suit. (Of course, this bid can mean other things, but we shall assume for this example that the above meaning is correct in the particular bidding system that West and his partner employ.) We may now adjust the probabilities of the spades, so that each spade in West's probability array has a slightly higher probability (say 0.45 instead of 0.33), and we may also adjust the probabilities of the high valued cards (aces, kings, queens and jacks) so that they give an expected high card holding which corresponds to a typical one spade opening bid. (If this bid is made with an average of 13 points, the ace counting 4 points, king 3, queen 2 and

Games, cont'd...

jack 1, then by making each of the high card probabilities 0.433 we give West an expectation of 13 out of the remaining high card points: there are 40 high card points in total and we hold 10 of them, leaving 30, and $13/30 = 0.433$). We should, in fact, give a slightly higher probability to a card which is both a spade and a high card.

Having assigned new probabilities to the spades and the high cards, we can then adjust the probabilities for the remaining cards in West's hand, so that the sum total of his probabilities is 13 (the total number of cards in his hand), and we can adjust the probabilities for each card in North's and East's hands by subtracting West's probability from 1 and dividing the result by 2, remembering to ignore all cards in our own hand.

So from his first bid we can make quite a lot of probabilistic estimates about West's cards, and hence about those in the North and East hands.

The bidding then passes to North, and depending on his bid we make adjustments to his probabilities using similar, logical arguments, and then we adjust the probabilities for West and East. This process continues until the end of the bidding — each time we acquire some information that increases the likelihood of a card being in a particular place, we increase the probability for that place and reduce it accordingly in the other hands. When there is some negative information about the position of a card we use it in a similar way.

By the end of the bidding phase a good bridge program should have a fairly accurate estimate of how each of the other three hands is made up. By summing the probability values for all the spades in a hand the program can get an estimate of how many spades that player holds. By summing the products of the high card probability $\times$ high card point values, the program can estimate the number of high card points in each suit in each hand. It will then be better able to plan its play of the hand, and of course the probabilities will be adjusted all through the playing phase.

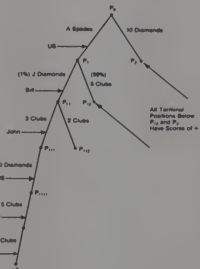
How to use Deduced Information

The most obvious use of our deduced probabilities arises when the probability estimates for all unseen cards are all either 1 or 0, i.e., we know where all the remaining cards lie. We then have a case of a perfect information game, and we can solve this game by performing a tree search to the end of the game. Even though there may be

three or more players, the tree approach should still work, though we must make certain assumptions about the way that the other players are going to make their decisions. For example, let us assume that we are two tricks from the end of a hand of our three-player card game.

We hold: A of spades, 10 of diamonds. Bill holds: J of diamonds, 5 of clubs. John holds: 3 and 2 of clubs. It is our turn to lead (remember that spades are trumps).

The program now constructs a game tree, of depth 6-ply. Part of the tree will look like this:



We assign to the terminal nodes of the tree, scores corresponding to the number of tricks won by each player, and we back up through the tree until we can determine which card should be played next. In this example the situation is simple because if we lead the A of spades first we may take two tricks, whereas if we lead the 10 of diamonds we can only make one trick. Note the use of the word "may." In order to make two tricks we need some help from Bill, who must make a mistake and discard the J of diamonds in the hope that our second card is the 2 or 3 of clubs and he will make his 5. But since we lose nothing by playing the A of spades first, that is clearly the best way to continue. How can we modify our traditional methods of tree-searching to cater for situations such as this one, in which we wish to allow for the possibility that our opponent will make a mistake? Fortunately the problem has been solved for us, by the ubiquitous Donald Michie, whose name crops up time and again in interesting research reports on various topics within the science of Artificial Intelligence.

Expected Values in Backed-Up Trees

Michie's method, which I shall discuss in some detail in a later article, is based on the assertion that when searching a game tree it is unreasonable to assume perfect play by the opponent, since there must always be a finite chance that he will not choose the best move. Let us see how this helps us to search the above tree.

We may simplify Michie's concept as follows: If there is a 99% chance that Bill will play the 5 of clubs from position P1, and a 1% chance that he will play the J of diamonds, then since the 5 of clubs will give us a score of 1 (i.e., we take one trick) and the J of diamonds will give us a score of 2, the expected value of our position P1 is

$$(0.99 \times 1) + (0.01 \times 2) = 0.99 + 0.02 = 1.01$$

whereas if we play the 10 of diamonds from position P0, the expected (in fact the certain) value of position P2 will be 1 (i.e., we will take one trick no matter how Bill and John play). Since 1.01 is greater than 1, we should play the A of spades from P0 because it maximizes our expected score. The reader will probably have realized by now that not only does Michie's method allow us to optimize our practical chances when we know exactly where all the unseen cards lie, it also enables us to use our probability estimates of the locations of the unseen cards, to build game trees which will help in the play of the hand. In other words, Michie has shown us how to play with the odds!

Task for the Month

Find or invent a simple card game in which information may be deduced from the play of the cards. (Avoid bidding games, unless you are extremely confident and have many free hours this month.) Write a program to play this game, modifying the probability estimates of the unseen cards in the light of the user's play. Experiment with various methods of adjusting these estimates until the program plays at least moderately sensibly. At the point in the game where exhaustive search will not be too time consuming, set up a probabilistic game tree à la Michie to search to the end of the game. □

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- (For more information on Bayes' theorem see any good book on statistics or probability theory.)

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Sorting: A Key Technique

While evaluations are important, the main focus of Creative Computing magazine is computer applications of all kinds. Many of these require that data be retrieved or sorted. Unfortunately, most programming texts focus on the bubble sort (or straight insertion) and, very infrequently, another technique (usually delayed replacement) and let it go at that.

Yet, except for comparison counting, the bubble sort is the least efficient. Tutorials and articles in Creative Computing demonstrate that the Shell-Metzner and Heapsort are from 50 to 13,000 times as fast as the bubble sort! Consider a sort of 100,000 items on a DEC System

Bubble sort	7.1 days
Delayed replacement	3.8 days
Heapsort	17.3 minutes
Shell-Metzner	15.0 minutes

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country. We do not believe that the "Computer priesthood" should confuse and bully the public. As Ted Nelson stated in the Computer Lib Pledge, we do not treat any question as a dumb question, since there is no such thing. We are against computer terms or systems that are oppressive, insulting or unkind, and we are doing the best we can to improve or replace such terminology or systems. We are committed to doing all we can to further human understanding and make computers easy to understand, interactive wherever possible, and fun for the user. The complete Computer Lib Pledge is contained in our May 1979 issue which we are furnishing free to new subscribers.

Computer literacy to everyone

The Creative Computing Software Division is participating with Children's Television Workshop in an important new venture, Sesame Place. These theme parks are being designed to bring interactive computer games and simulations to young children (and their parents) and remove the mystique of computers from the youngest segment of our population. In addition, we are participating in projects with several school systems and museums to write reading comprehension and ecology simulations software. We are also involved in a major college-level computer literacy project.

As a subscriber to Creative Computing, you will benefit from all of these activities. Creative Computing is the Number 1 software and applications magazine. Subscribe today — 12 issues for \$15 (\$9 saving over the newsstand price). Or, beat inflation and get 36 issues for just \$40. Money back if you're not satisfied. Send payment or Visa, Master Charge or American Express number to:

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Apple~Cart

Chuck Carpenter

Correspondence is always welcome and a response will be made to those accompanied by a SASE. Send your letters to: Chuck Carpenter, 2228 Montclair Pl., Carrollton, TX 75006.



Missed last month due to a heavy work schedule and a personal illness. My work schedule may cause me to miss a column from time to time. But, keep sending the letters. I will answer them all and as timely as the complexity of the answer permits.

Input From Readers

Here's a couple of ideas from Jim Levin. The first is a clever idea to protect the system from accidental reset. Figure 1 shows a diagram of the device. The material is heavy paper such as a 3x5 index card. (I

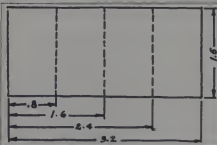


Figure 1

would also suggest certain types of light gauge plastic). Cut the rectangle to size and fold it into a square tube 0.8 inches on a side. Tape the open edges together. Slide the tube down over the RESET key. And there

you have it; RESET protection with material cost less than 1 cent and installation time under 3 minutes. Jim suggests taping the sides away from the keys to the surface of the computer.

Jim's second idea puts a volume control on the speaker. By using an inexpensive trimmer type variable resistor, you can reduce speaker volume to any comfortable level. Connect the control as shown in Figure 2.

Mount the resistor so the screw-

speaker which I connect or disconnect depending on how late at night it is. I decided to make it a little more sophisticated by hooking things up as shown in Figure 3.

I mounted the switch and resistor by drilling 2 1/4 inch holes in the case. The jack for the external speaker is mounted on the rear apron. Now I can select either speaker with volume control. My external speaker is a Radio Shack mobile speaker. It's a 4 inch speaker in a plastic case. But it has good sound with lots of volume.

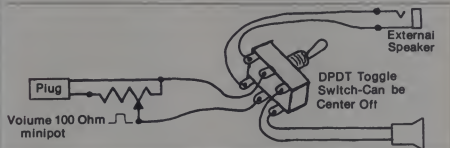


Figure 3

driver slot is accessible from one of the ventilation slots. Remember that this modification will void your warranty. Make your decision accordingly.

The volume control idea from Jim stimulated my thinking about my system. I have been using an external

Again, these modifications will void your warranty.

Fred Gunther sent in another idea for program stoppers. He has solved the same problem another way. Fred suggests that you provide one of the following subroutines:

Integer Basic

```
50 PRINT "PRESS THE";POKE 50,63;PRINT"RETURN";
55 POKE 50,255;INPUT"KEY TO CONTINUE.";IN$;RETURN
```

Applesoft

```
50 PRINT "PRESS THE";INVERSE;PRINT"RETURN";
55 NORMAL;INPUT"KEY TO CONTINUE.";IN$;RETURN
```

Then in the main program, each time you want to pause, you need only:

```
...GOSUB 50
```

The Inverse lettering for RETURN helps to make it obvious that the user



Figure 2

presses one key rather than type in 6 letters.

More Reader Input

This great idea from Bob Sander-Cederlof will help you with some of your booting problems. The problem is that the boot program, or the so-called HELLO program, must be in either Integer Basic or Applesoft. It cannot be both at the same time. So, if you use the Applesoft version, anyone using your disk without Applesoft gets the message, "LANGUAGE NOT AVAILABLE" when the disk is booted. Or, if you use an Integer Basic boot program, the person with an Apple II Plus and no Integer Basic gets the same message.

According to Bob, there is an answer. He discovered it by reading the documentation that comes with the Apple Writer Text Editing System. The key is to remember that if the boot program is written in Applesoft, and if, furthermore, there is no Applesoft in ROM in your machine, the DOS tries to load and run an Integer Basic file with the name APPLESOFT. So, INIT your disk with an Applesoft boot program written in Integer Basic and store it on the disk under the file name "APPLESOFT."

When you boot this disk, DOS will try to boot the program named HELLO. If you have Applesoft on ROM, this will succeed, and you will be up and running. If you do not have Applesoft, DOS will attempt to load it from the disk by running the Integer Basic file named APPLESOFT which is really your other boot program.

Another RESET protector idea comes from George Norkus. This one uses an "O" ring as a stiff spring to make reset harder to push. The O ring is a National AS-108. Remove the reset key cap and slide the O ring over the plunger stem. Reinstall the key cap. Now, the hard-to-push key won't allow accidental resets. Another option, in place of the O ring, is a piece of closed cell foam. A piece about an eighth of an inch thick and a half inch in diameter will do fine. Cut an X or cross in the middle. Slide this down over the plunger as with the O ring.

I've noticed that the new Apples have a much stiffer spring on the reset key. Also, an option is now available in which you have to use CONTROL and RESET together. The new features don't appear to be available for older models. So, the

ideas coming from readers will be helpful to many of us.

Feedback

In the March Apple Cart, there were several programs for loading assembly language into memory from Basic. I even went so far as to use the same zero page program in examples for page 3 use. *Can't be done!* The opcodes for instructions other than page 0 are different. The correct program for page 3 was sent to me by Thomas Giacchi. Here is his page 3 version of the Random Tones program:

Machine Language

```
3000-
0300- FF      7F7
0301- FF      7F7
0302- AB 30 CO LBA      SC030
0303- 08      SET
0304- 00 00      BNE      SC030
0305- CE 01 03      DEC      SC031
0306- F3 08      BEQ      SC031B
0307- CA      DEX
0308- 30 F3      BNE      SC030B
0309- 00 00      BNE      SC030B
0310- AE 00 03      LDR      SC030B
0311- AC 02 03      JMP      SC0302
0312- 80      RTS
```

Pokes

```
POKE 770,173      POKE 781,202
POKE 771,48      POKE 782,208
POKE 772,192      POKE 783,245
POKE 773,136      POKE 784,174
POKE 774,248      POKE 785,4
POKE 775,5      POKE 786,3
POKE 776,206      POKE 787,76
POKE 777,1      POKE 788,2
POKE 778,3      POKE 789,3
POKE 779,240      POKE 790,96
POKE 780,9
```

In the READ...DATA routines, change the DATA values in the POKE commands. The string H\$ will contain the data bytes from address \$302 to \$316. And the starting address should be 770, not 768. Thomas is using 768 and 769 to hold the pitch and duration values. These changes will allow the program to work in page 3 memory locations.

Software Over The Phone

Software for the stay-at-home shopper (and energy savers) is available over the phone. Several very useful and well done programs are now available from the Telephone Software Connection at (213) 329-3715. I have the phone answering program, the program to send a picture and the program to play Go Moku over the phone. I have used the answering program the most, and it makes your Apple respond like a miniature bulletin board system. My interests in electronic mail make this a most useful program.

On your first call, you will be asked to complete a short "credit application," which consists of your name, address, phone number(s), and Master Charge or Visa number. Then

you will be asked to select a password to protect your account from unauthorized purchases.

Immediately after answering the questions, you will be shown a list of the programs currently available, and you are invited to select any of the free programs that are on the system. After you make your selection, it will ask you to verify that it is correct and then it will attempt to transfer you the program. If you used a "dialer" program to call the system, it will detect this and ask you to get out of that program so it won't get in the way of the transfer process. If you aren't in Applesoft it will ask you to get into it. Then sit back and watch one of the slickest program transfers you will ever see, including the saving and locking of the program onto your disk.

The program selection is unique and, as far as I know, they are not available elsewhere. One is an answering machine program that will answer a modem phone line with your name 24 hours a day. It will also let you call in from a remote terminal to get your messages and operate your system. Included are some excellent security routines to prevent "crashers" and an outgoing message capability to let you leave messages that will be automatically given to selected friends, when they call in. Other programs let you send any type of program to another computer, send a 16 line message to selected bulletin board systems, send a high-res graphics picture over the phone, and play the game Go Moku over the phone with another Apple owner.

Ed Magnin of Telephone Software Connection, says that this system's main advantages are convenience and flexibility. The convenience comes from the ease of purchasing software at anytime of day or night without stepping out of your house, and without worrying whether they have just run out of your favorite program. The flexibility is that any new programs can be on line for sale the instant they are ready, complete with documentation (included as part of the program). If updates are ever needed they can be on the system as quickly and easily as the original program.

The average program for sale takes about seven minutes (13K) to transfer. If you add three minutes for sign-on and sign-off, that means an average ten minute connection. Based on the phone rates from California to Maine, this would cost less than \$4.00 during the day, \$3.00

Apple, cont'd...

after five or \$2.00 after eleven or on weekends. That is less than most postage and handling charges, and those outside of California save the 6% sales tax.

The phone transfer system will work with the D.C. Hayes modem or the Comm. card and an acoustic modem. Be sure your first free program is the dial TSC program. Then when you call back for software, you can do it automatically. TSC is adding new things all the time. By the time you read this, there will be a nice selection of programs for you to try. And, the transfer process really is fascinating.

S-C Assembler II

In the May column, I mentioned using an assembler other than the mini-assembler in the Apple II. And, for those of you with the Apple II Plus, the only way you can do any machine language assembly is with an "external" program. I have used the S-C Assembler II for a couple of years now. There are a number of assemblers on the market, but none as easy to use by the casual user. The S-C Assembler II (S-C A2) includes many useful features for creating, editing, assembling, and testing your assembly language programs. Let's take a look at some of these features:

- Similarity to Basic - S-C A2 is completely integrated with Basic routines. If you are familiar with Basic in your Apple II and its syntax, you can easily understand the S-C A2. Works on all Apple models.
- Compatible with the Apple II mini-assembler-input format and assembled output will be familiar to users of the mini-assembler. Those of you starting on the Apple II Plus will appreciate the standardized format. Machine language is made easier and more powerful with extensions such as labels, symbolic addressing and comments.
- Line Oriented - S-C A2 uses line numbers like Basic and has complete screen editing features and capability to renumber, you can add-to, delete and change your program easily and conveniently.
- Compact Size-The tape version will easily run, with lots of working space, on a 16K ma-

chine. The DOS version, because of DOS, requires more memory; a 24K system is the minimum.

- Cassette and DOS Support-Both the tape and DOS versions support standard Apple II I/O syntax. Also, both versions include an internal printer driver routine and/or the support of peripherals using the PR# command.

For the newcomer to the world of assembly language, the S-C A2 will provide a familiar way to start writing your own 6502 assembly language programs. Once you become more skilled, there are several S-C A2 extensions that will facilitate your program writing. For instance:

- Pseudo Opcodes-There are seven codes called assembler directives in the S-C A2. These codes allow you to define the origin (.OR), define a target address (.TA), define equates for address expressions (.EQ), define data (.DA), define ASCII strings (.AS), define HEX strings (.HS) and end the program or test segment (.EN).

There are 13 assembler commands that provide functional program development and control. The assembler is fully compatible with DOS 3.2, and all the Apple II monitor commands are usable inside S-C A2. I found using the assembler as easy to use as programming in Basic. I think you will find it enjoyable to use too. You can purchase the S-C Assembler II at many computer stores. If it is not available where you are, you can order by mail from S-C Software, P.O. Box 5537, Richardson, TX 75080. The price for the tape version is \$25.00 and for the DOS version, \$35.00. Both include a 40 page reference manual.

Apple II Simulators

Using the Apple II as a development system for two popular microprocessors is now possible. An 8080 and an RCA 1802 simulator by Dann McCreary will do the job. The simulators allow you to enter opcodes and data using the format of the particular computer. The simulators then interpret the hexadecimal code as though a program was being executed on the particular computer.

Included in the package are a tape and supporting documentation. The tape includes the interpreter manual, the interpreter, a sample program and a disassembler for micro's assembly language code. The documentation includes a listing of the sample program, a summary of all

the instructions and commands found in the operators manual and a programmers reference card. The package is designed to run on a 16K or larger system.

To make effective use of the Apple II capabilities, Dann has created special codes for calling 6502 routines. This way you can develop your software and take advantage of Apple II features at the same time. Some of the vacant opcodes for the computer are used to include a mnemonic and corresponding opcode for 6502 calls. By using the opcode in your routines, a variety of programming options can be included.

Developing the particular code requires that you first hand assemble your program. Then, using the Apple II monitor routines, enter the HEX machine code into memory starting at address \$1000. Now, call the simulator-Interpreter at address \$800 and execute the program using simulator commands. All the registers for the micros are displayed on the screen and complete editing and debugging commands are available. All I/O ports, external flags and interrupts are implemented by the simulators. Once the program is written and debugged, you can implement the code on your dedicated controller.

Both packages include instructions for customizing the programs to fit your system configuration. And, both are available for \$21.50 from Dann McCreary, Software Design, Box 16435, San Diego, CA 92116.

The New Apple II Reference Manual

Those of you who have only recently purchased your Apples probably got one with it. The new reference manual replaces the "Red Book." For anyone interested in learning all about the innards of the Apple, the new reference manual is the book to have. Such infinitely useful items as schematics and complete pin-out data on all connectors are provided. Tables of page zero usage for each language are included. (Shows where all the spots are not used so you can tuck a byte or two of data away.) And, all the PEEKs, POKes and CALLs to the game paddle and other I/O functions are tabulated for you. The differences between various revisions of Apple mother boards are discussed, and so are the features of the autostart ROM. There is much, much more, and if you didn't get the new reference manual with your Apple, it's an excellent addition to your Apple library. □

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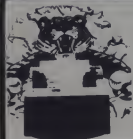
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Outpost: Atari



George Blank

Resources

Where do you get more help and information about your Atari? Obviously, *Creative Computing* is one source, and there are several others. If you are a beginner, the Atari Basic self-teaching guide that came with your computer will get you started. When you send in your warranty card, you will receive the Atari 400/800 Basic Reference Manual, which is much better, and actually answers most of your questions. I had three questions when I first started programming the Atari:

1. How do you concatenate strings?
2. How do you array strings?
3. How do you obtain keyboard input without stopping the program?

Atari had given me the name of someone in the plant to call for questions, so I called and left my questions. Within hours they called back with the answer: "We don't know." The next day my preliminary reference manual arrived, and it had answers to all three questions! The answers were not easy to find, but they were there.

1. To concatenate a string variable, follow these steps:

- a. Dimension the receiving string large enough to hold the combination.
- b. Determine the length of the original string with the LEN function.
- c. Assign the string to be combined to the next location in the receiving string.

Here is a program to do it:

George Blank, Foster Road, Milford NH 03055

```
10 DIM AS(10):DIM BS(5)
20 AS="THIS"
30 BS="+THAT"
40 AS=LEN(AS)+1=BS
50 PRINT AS
```

2. String arrays are difficult in Atari Basic. Essentially, you have to dimension a very large string, store all other string data as substrings, and do your own bookkeeping to keep track of where each item is. The Alphanumeric Sort routine in Appendix A of the Reference manual uses this method. One advantage of Atari Basic is that there is no arbitrary limit to the size of a string, as there is in Microsoft Basic, so there is a lot of flexibility.
3. To strobe the keyboard, PEEK location 764 in memory to determine when a key is pressed. To obtain a single character from the keyboard, OPEN the keyboard as an input device and use the GET command:

```
10 X=PEEK(764):IF X<255 THEN PRINT X
20 GOTO 10
10 OPEN #1, 4, 0, "R:"
20 GET #1, A
30 PRINT CHR$(A)
```

Other sources of information include *Compute* magazine, which divides its attention between the Pet, the Atari, and the Apple. It is \$9 a year, 6 issues, from *Compute*, 900 Spring Garden Street, Greensboro, NC 27403. SoftSide Publications has announced a game magazine for the Atari, to include several programs in each monthly issue. Write SoftSide: Atari, P.O. Box 68, Milford, NH 03055. The subscription rate is \$15 a year.

I have since received the regular Basic Reference Manual, and it is even better than the preliminary one. One nice new feature is an excellent memory map. Some information is still not released, but I get the impression that this is because Atari is reluctant to release it in its preliminary form, not because they are trying to hide something. I know that they have been particularly helpful to friends of mine who have signed non-disclosure forms.

Tutorial Series

One excellent source of information is *Iridis*. *Iridis* was first advertised as a magazine, but now describes itself as "a series of tutorials about the Atari Personal Computer." It is sold, not by subscription, but by individual issues.

Iridis I contains four programs with explanatory articles, three columns, and an explanation of their format for printing control characters. You can purchase it either with the programs on cassette (\$9.95) or on disk (\$12.95).

The four programs include "Clock," a high resolution wall clock with moving hands, ticking and chimes; "Zap," where a joystick-controlled snake moves around the screen eating bits of food and growing; "Logo," which displays the *Iridis* logo in dozens of different shades, with instantaneous changes from one color to another; and "Polygons," which constructs geometric patterns.

Each program is listed, and a "behind the scenes" article following each listing explains the program in detail. These listings are very well

Outpost, cont'd...

done, and contain fascinating glimpses into programming techniques. For example, you can test to see if the START button is pressed by checking to see if memory location 53279 contains anything other than 7.

The three columns are "Novice Notes," with programming tips for the beginner, "Hacker's Delight," which goes into detail about how the machine works, and "Oddments," which contains features too short to deserve an article, but too significant to be ignored.

Iridis I comes in manual format, 6 inches by 9 1/2 inches, and contains 32 pages. The print is quite small, and appears to be typeset with a small computer word processor and printer. Except for a chart on the last page showing the Atari control characters, there are no illustrations.

You may order *Iridis* from The Code Works, Box 550, Goleta, CA 93017

Itty Bits

As a closing feature, here is a calculator program I use frequently

to balance my checkbook, do my taxes, and for any other adding machine functions. Although it is very short, it is one of my favorite programs. To clear the memory, enter the present value of the accumulator (B) as a negative number.

10 INPUT A : B=B+A : PRINT B : GOTO 10

Do you have a tiny program that you have found useful? Send it in for *Itty Bits*. You won't win a fortune, but you might see your name in print.



"George, call the repairman! Rumpus is starting to solve non-linear cubic splines equations again, and refuses to clean the house!"

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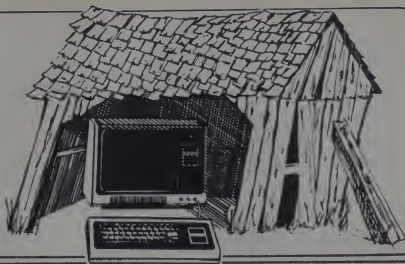
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CIRCLE 217 ON READER SERVICE CARD

TRS-80 Strings

Stephen B. Gray



For the twentieth TRS-80 column, we unwind a CLOAD cover-art program to find out what makes it tick, check out some of the CLOAD tapes published in the last year and a half, examine the Cook Labs azimuth-check meter and two Cook programs, take a look at a checkers program by Lance Micklus and at *Creative's* Air Traffic Controller program and also at a Dungeon Explorer game, and end with a short program that produces one of the most startling displays you've ever seen, and which you're hereby challenged to predict before you RUN it.

A pair of TRS-80 monitors in one of the executive offices showed that the day's TRS-80 production up to that moment, around two in the afternoon, included 131 Level-I machines; 127 with 4K of memory, 4 with 16K.

CLOAD Cover Graphics

Now that we've looked awhile at creating graphics with a TRS-80, let's check out some of the graphics available in the world of software.

One source is the "covers" of CLOAD magazine, which is on cassette. Each issue, which provides games and practical programs, starts with a standard display of CLOAD in big letters, plus the issue's date, at the top.

The bottom two-thirds of the "cover" is reserved for a graphics display that creates a picture, over and over, until you're ready to BREAK and

load the next program.

CLOAD started in March 1978, has programs for 4K Level-I on one side of the cassette, and most of the same programs for 16K Level-II on the other side.

Incidentally, several readers have told me they know for a fact that Radio Shack no longer manufactures the Level-I TRS-80. But when I visited Fort Worth a few weeks ago and was taken on a tour of the assembly plant, a pair of TRS-80 monitors in one of the executive offices showed that the day's TRS-80 production up to that moment, around two in the afternoon, included 131 Level-I machines; 127 with 4K of memory, 4 with 16K.

The June 1978 CLOAD cover-art program fills the lower part of the display with a random number of graphics blocks. Then a flickering "bomber" block scans the area, from top to bottom, left to right, wiping out each block in turn with an "explosion" the size of a quarter.



The full cover program consists of 118 lines and a total of 179 statements. Let's peel it down to the essentials.

We can easily peel off the lines that print the outlining rectangle, the words at the top of the cover, and the copyright message that appears after the bomber has emptied the screen, and before the display starts over again. That cuts the program down to 69 lines.

By eliminating the explosion graphics, the program is now 13 lines

long. The explosion takes so many lines because it consists of a grid of many blocks that are SET and RESET in a blossoming pattern that fades away.

Of the remaining 13 lines, one can be peeled off to reveal the core program of 12 lines with 14 statements.

When you get down this far, by the way, it's best to print out the program, so if you remove a line and find you shouldn't have, you can easily put it back. If you don't have a printer, write down the line before you remove it, or you'll have to CLOAD the original program again and start all over.

The core program, with a CLS added at the beginning, is

```
10 CLS
20 P=RND(358)
25 ZP<18THEN28
80 FORI=1TOP
85 Z=RND(112)+7
90 Y=RND(43)
95 ZY<18THEN+8
98 SET(X,Y)
100 NEXTI
105 FORY=7TO119
110 FORY=19TO43
115 SET(X,Y)RESET(X,Y)
120 NEXTY:NEXTX
```

Lines 20-25 select a random number of 10 to 350 graphics blocks. Lines 80-100 set those random blocks in a rectangular field in the bottom two-thirds of the screen, between $x=7$ to 119 and $y=19$ to 43. Lines 110-115 and 170 delineate the field for the bomber to flit through, turning on and off as it runs from top to bottom ($Y=19$ to 43) and left to right ($X=7$ to 119).

Line 160 is the key line. It turns on the flickering bomber block and, as it turns the block off, also turns off any other block that may have previously been there. In the full program, the explosion often wipes out more than the block it's centered on, because of the RESET lines in the explosion subprogram.

To add a little more flicker to the moving bomber block, line 120 can be put back in:

```
120 IF POINT(X,Y)=0 GOTO 160
```

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CIRCLE 146 ON READER SERVICE CARD

Strings, cont'd...

Can you figure out why that line adds more flicker?

We'll look at another CLOAD cover-art program again soon, thanks to the kind permission of CLOAD publisher Ralph McElroy. Many of the back issues are available, by the way, at \$3.50 from CLOAD Magazine, Box 1267, Goleta, CA 93017. A year's subscription is \$36, six months for \$20. Volume II of the "Best of CLOAD" is \$15 a copy.

When the IQ is 3, the computer takes from 2 to 4 minutes to move, and can fool you with what seems to be a poor move, but often turns out to be a trap.

CLOAD Highlights

These are some of the highlights of CLOAD tapes published since I last wrote up a few:

Reaction Test: How fast can you react to a stimulus? (Dec '78). **Sketch:** simulates the old Etch-A-Sketch, can also erase and store (Dec '78). **Jukebox:** plays any of six tunes through an AM radio (Dec '78).

Road Rally: Speedway, racing around track (Jan '79). **Corporation:** simulates a small company; you make decisions (Feb '79). **Disassembler (Feb '79):** Worm: guide the worm through the maze (Mar '79). **Hustle:** chase peripatetic target (Apr '79). **Grapher:** draws graph in polar or cartesian coordinates (June '79).

Bounce: try getting ball into pockets (Jul '79). **Psycho:** moving graphics display; you set parameters (Jul '79). **Grand Prix:** car race, with variables (Aug '79). **Poke:** machine-language monitor (Sep '79). **Psycho-Logic:** game of mathematical deduction; 19 levels of difficulty (Nov '79). **Blockade:** two-person real-time test of reaction time (Dec '79). **Tape Test:** writes test pattern on tape, checks it out, shows what volume level is best (Dec '79).

Hi Calc: four-function calculator; 1,500-digit precision (Jan '80). **RAM Test (Jan '80):** Monitor: similar to T-BUG (Feb '80).

My favorites among these are Psycho-Logic and Hustle. The first is the most devilishly conceived mathematical game I've seen yet, and requires a second computer to play it above the fourth level, unless you're a math genius.

Hustle is a great challenge to your patience and maneuvering skill, as the screen fills more and more with the longer and longer tail of the snake-like trace, as you try to hit the elusive targets without hitting the walls or the trace itself, and without reversing directions.

Azimuth Check

If your Level-II TRS-80 has no problems reading program tapes you've made, but does when trying to read tapes written elsewhere, Cook Laboratories says perhaps your problem is with the azimuth of your cassette recorder's record/play (R/P) head.

The R/P head is essentially a C-shaped magnet with a very narrow gap where the magnet comes around to almost touch one end to the other. The gap looks like a thin vertical line, and the R/P head is installed with the gap as vertical as possible.

How do you check this verticality, this azimuth? One of the very few ways is to use the "Peek-80," which is the PK-80 Peak Reading Voltmeter (\$49.50 from Cook Laboratories, Inc., 375 Ely Ave., Norwalk, CT 06865).

Using the op-amp PK-80 is simplicity itself. Just take the EAR plug from your cassette recorder, plug it into either of the I/O jacks on the meter, and run the supplied patchcord from the other I/O jack to the EAR jack in the recorder.

Play the "Azimuth Calibration" side of the tape, and "adjust azimuth screw for maximum meter reading," using the supplied Philips-head screwdriver.

The brief manual notes that you can "turn a cheap cassette over, and the azimuth may appear to have changed. This is not the fault of the cassette deck; it is the fault of the cassette."

Chrome tapes are recommended, and Cook Labs sells chrome tapes, from a C-10 at \$3.25 to a C-60 at \$5.25. These cassettes are said to be "video, not audio chrome tape." They also offer software-duplication facilities.

Cook Labs also has a free service. As the accompanying "Digital Bucket" information sheet puts it, "If the reader would like to know what the cassette-deck speed is, CSAVE any TRS program, Level-I or Level-II, short or long, or a data file, or anything—send the cassette to Annette at Cook Labs... with 28¢ return postage (stamps acceptable). Same-day turn-around follows, with notation on N% plus or minus; also a note on azimuth condition. Cassette returned with note; no charge."

According to a friend of mine who's the chief engineer of a radio

station, and who tests hi-fi equipment for an audio magazine, and who is also becoming a personal-computer expert, azimuth isn't all that important in a TRS-80 cassette recorder. To make trouble, he says, "the azimuth would have to be so severely tilted that the machine wouldn't record anyway, because the head would probably be falling out of the deck."

He notes that the TRS-80 uses an audio recording system, not digital, and says "if the tape is good for audio, it's good for digital" in such a system. He recommends Maxell's UD, TDK's AD or SA, and Memorex's MRX3.

Azimuth does make a difference in high-fidelity recording, he says, because a tilted azimuth results in the loss of high frequencies.

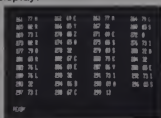
Steve Leininger, designer of the TRS-80, says that when azimuth is out of alignment, the recorded pulses tend to spread out a little wider. This is no problem if you have had the free cassette modification installed, because it has a digital one-shot in it.

As for using chrometapes, he says the audio recording system in the TRS-80 is not set up with the correct bias for chrometapes; and audio tapes, such as the Radio Shack "Gold" tapes, are better.

Two "convenience programs" are on the other side of the DuPont chrome-tape cassette, Peek and RUN4.

Peeker

The three-line Peeker program displays the contents of any RAM memory locations you choose. Just enter the low and high bytes, and the screen is immediately filled with a four-up display.



You might try adding a couple of lines to Peeker, to also print the alphanumeric equivalent of the RAM-memory contents. Then ask for the contents of locations 261 through 299. Actually, you can do that with only

```
3 FOR X=261 TO 299
4  A$=PEEK(X)
5  PRINT X; A; CHR$(A);
6  NEXT
```

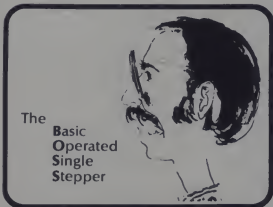
RUN4

The other Cook Labs program is a two-line utility that "brings string

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This program sold on cassette for \$29.95 and works in Level II or DOS (works under TRSDOS 2.1, 2.2, 2.3, NEWDOS 2.1 we do not have NEWDOS-80 yet to test) and comes with 13 page manual. Automatically relocates itself to not interfere with other machine language programs that you have in high memory.

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CIRCLE 182 ON READER SERVICE CARD

Strings, cont'd...

graphics of your choice, offering quick opportunity for selection." Rewritten for this column, the two lines become

```
1 CLS
2 CLEAR 59
3 INPUT "ENTER ASCII CODE FOR DISP. AT IQ"
4 FOR N=3 TO 2+3
5 PRINT HI STR$(N)
6 NEXT
7 GOTO 4
```

This displays a row of characters equivalent to the ASCII code, plus three rows above and three below, of the three preceding and three following ASCII-codes equivalent characters.



Useful, but I still prefer my version (Nov '79, p 179), "which will print a full set of graphics characters next to their ASCII codes, give you a moment to select one by number, ask for that number, and then print an allower pattern using that character, to show you what it would look like in a continuous pattern."

The Mean Checkers Machine

The latest TRS-80 game from the deft hand of Lance Micklus is The Mean Checkers Machine, which plays checkers at four skill levels. The program is written in Fortran, and runs in only 12K because several sub-routines are in assembly language.

The cassette version runs on a 16K Level-II machine, and is \$19.95. The disk version runs under TRSDOS, requires 32K and a single disk drive, and is \$24.95. If your local computer store doesn't have The Mean Checkers Machine, you can get it from The TRS-80 Software Exchange (17 Briar Cliff Drive, Milford, NH 03055). An annotated source-code listing of the entire program may be offered at a later date, if there's enough demand for it.

If you win, the computer says: SHUCKS!!! I LOST. But to win, you have to eliminate all your opponent's pieces from the board. If you place him (the computer) in a position where he can't make any legal moves, a stalemate results, and no matter how far ahead you are, the game ends in a draw. This can be exasperating, especially if you have eight kings and the computer is down to one piece. It can happen.



The checkerboard is labeled A to H across the tops of the columns, and 1 to 8 down the rows. My first move was B6-A5, and the display changed to reflect that move as soon as I pressed ENTER. The computer considers its move, announces in print what move it intends to make, flashes on and off the X representing the piece it will move, and then moves it.

During the first games I played, the computer took from 12 to 28 seconds to decide what move to make. The manual says the maximum is 40 seconds. That's at an IQ of 2, the level at which the computer normally plays. You can change the IQ anytime it's your turn. At an IQ of 1, the computer plays a novice-level game, and you can beat it unless you're six years old and just learning. The computer's average move time is about 5 seconds at an IQ of 1.

At an IQ of 2, the computer plays an average game. It makes mistakes just as you might, unless you're an expert. You can beat the computer if you're careful. When the IQ is 3, the computer takes from 2 to 4 minutes to move, and can fool you with what seems to be a poor move, but often turns out to be a trap.

At an IQ of 4, the computer takes 10 to 20 minutes to find a move. This is the computer's championship level, and is almost impossible to beat unless you're an expert.

If you haven't got time to finish a long game, or if you'd like to go back and play a game in different ways from a particular point in the game, you can SAVE a game on tape or disk, to record the current checkerboard. Then you can call it up at any later time, and play from that point on.

If your move is illegal, the computer displays *** INPUT ERROR *** and again prompts you for a move.

When you're ready to give up, type QUIT instead of your move, and the computer resets the board. If you want the computer to go first, type UMOV instead of entering a move. Although UMOV works anytime during a game, the manual notes that "it is only legal at the beginning of a game. The computer assumes you are an honest player." (No, you can't make the computer play against itself.)

The Mean Checkers Machine is Micklus' third checkers-playing game.

He wrote the first in Sigma 6 Basic, based on the checkers program in *Creative Computing's* "101 Basic Computer Games" (p 73), with added improvements.

Later Micklus transferred it to the TRS-80 in Level-II Basic, and then converted it to Level-I Basic. But still it didn't play what Micklus considered a very good checkers game.

So, borrowing the principles, he rewrote the game completely, using a one-move look-ahead. The game was better but much too slow. So he bought Microsoft's Fortran package, which he found to be "the perfect language" for his use. According to the manual, "Fortran compiles into machine-language code which executes many times faster than Basic, yet offers the kind of powerful high-level instructions and array-handling found in Basic."

To make the program run on a 16K Level-II machine, some of the sub-routines were written in assembly language, using Microsoft's M80 compiler. Making the jumps optional also helped keep the game in 12K. Micklus says he may someday write a checkers game in which you have to jump.

If you don't have a multi-track mind, an unflappable disposition and the ability to think clearly in the face of impending air disaster, don't buy Air Traffic Controller.

In the display, the squares measure about $\frac{3}{8}$ by $\frac{3}{8}$ inch, x is used for each of the computer's pieces, and O for each of yours. These, and all the other letters and numbers on the screen, are double-width. When you get to the king row, your O becomes O'; likewise the computer's piece becomes X'.

Just in case you're not charmed by such simplicity, the manual notes that the screen-display format "was chosen because it clearly displays the board, even though it is less dazzling than other board-type games. The author feels there aren't enough computer games small children can play. This display is less confusing to children, even if it doesn't impress daddy's computer friends." So there!

The computer plays on the offense, with an aggressive game; it isn't afraid to go after you. Toward the end of the game, it has been programmed to attack, which is why Micklus called it The Mean Checkers Machine.

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ESP-1: \$29.95. Assembler, Editor, Monitor (8080 semantics).
LS1-1: \$8.00. Listing of Level-1 BASIC with some comments

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All that's required is a standard cassette jack connected to Ground and a readable single bit input port. Driver software is provided along with instructions for writing lightwave applications. And tell your local Dealer that Esmark's got a Dealer package he won't want to miss out on. Delivery is 3 to 6 weeks from receipt of your order. C.O.D.'s are extra but will be shipped within 2 weeks. All prices are F.O.B. Mishawaka, Indiana. Indiana residents add 6% sales tax.

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Strings, cont'd...

Air Traffic Controller

If you have a multi-track mind, an unflappable disposition and the ability to think clearly in the face of impending air disaster, don't buy Air Traffic Controller, a machine-language simulation for the Level-II 16K TRS-80, from Creative Comp., Inc.

But if you think you can keep calm while 26 aircraft, both jet and prop, are heading into the airspace you control,



and you can either pass them through your area safely or land them properly at the two airports, then you might consider sending in \$7.95 (plus \$1 for shipping) for this "absorbing and stimulating simulation," as the Creative ads put it. The simulation was written by David Mannering, a professional air traffic controller.

Even before you load this game, you've got to learn many rules, all about the aircraft speeds, altitudes, headings, fuel, etc.; requirements such as "all active aircraft must be separated by at least 3 miles or at least 1,000 feet of altitude at all times"; instructions on how to guide aircraft; and enough more to thoroughly confuse you until you've read it all several times.

To quote from the instructions, "To begin the game, you select the number of minutes you wish to play (between 16 and 99). This is the amount of time you have to process all twenty-six aircraft." Select 16, and the game will be over within one minute, due to immediately impending disaster, unless you're a controller and have memorized all the rules. As the instructions put it, "The record time for successfully completing this simulation stands at 21, which is truly outstanding. Novice Air Traffic Controllers should try a time of 65 or higher to start."

This is not a game for the faint-hearted, the indecisive, or those who prefer batch-processing instead of real-time operations. Play it at your own risk.

Dungeon Explorer

This Level-II 16K single-player game was written by Matthew D. Kiriazis, and is \$8.50 postpaid from Software Exchange (2681 Peterboro,

W. Bloomfield, MI 48033). (This is not The Software Exchange, of Milford, NH.)

As an adventure game, Dungeon Explorer is rather limited. The dungeon is small, so you can't go very far without having to backtrack. There are only three rooms in the dungeon: an "empty and bloody chamber," a room with a chest, and a room with a flag; all the rest is corridors and intersections.

Eight monsters are supposed to be in the dungeon, but only the "nasty orc" and the "hungry ghoul" showed up while I was playing. Actually, "as the characters progress, they will face stronger and stronger monsters," but I couldn't get interested enough to play that long.

During a run, your character often keeps running into the same problems again and again, finding the chest or the potion over and over.

During a RUN, your "character" often keeps running into the same problems again and again, finding the chest or the potion over and over. If he declines to take the stairway out of the dungeon, he meets a nasty orc, and if he decides to run rather than fight, he comes upon the stairway, again and again.

Your character can be killed by the orc or ghoul, but he's almost always "raised back to life" and you're told to "be more careful." Now and then he can be killed permanently, and a gravestone is drawn.

Theoretically, the challenge is to avoid getting your character killed, and to advance him up "through the ranks" from recruit to super-hero, but the game is too limited in scope, too poorly written, and too boring to offer any real challenge.

Short Program #11

Jim Raden of Maumee, Ohio, sent in a short program that creates a startling display you might not be able to predict from the program itself:

```
10 FOR A=155 TO 1 STEP -1
20 FOR B=15346 TO 14393 STEP A2
30 POKE B, 191
40 NEXT B
50 CLS
60 NEXT A2
70 GOTO 10
```

Jim's letter says, "This one isn't useful at all, except maybe for some type of game. I'll let you try it out yourself to see what it does." □



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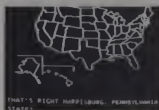
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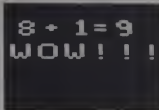
Creative Computing offers a wide variety of uncomplicated user-oriented educational programs. **Study Made Easy** for the PET (CS-1202) will create study drill tapes for any subject automatically. The computer guides you, step by step, through the entry of questions and multiple choice answers. The package includes three prepared drills. From U.S. Presidents to Lacrosse rules, the versatile programs of **Study Made Easy** will create study drills for you automatically. It's well worth the price of \$14.95.

CAI Programs offers a diverse group of study aids. **U.S. Maps** uses high resolution graphics to help students learn the states and their capitals. **Spelling** increases its pace as you progress. **Math Drill and Add with Carry** will help you with mathematics basics at your skill level. The **Know Yourself** package (CS-4301) helps you investigate society's effects on your behavior, how your life style affects your life expectancy, and how your attitudes are affected by society's concept of sex roles. **CAI Programs** and **Know Yourself** are available individually on cassette for \$7.95 each or on one disk (CS-4503) for only \$14.95. Cassette versions will run in 16K and the disk requires 32K. These are for the Apple II.

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Ecology Simulations-2 (CS-3202) explores problems in environmental and health sciences. In Malaria, Pollute, Rats, and Diet the user can attempt to end water pollution, rats in a city slum, or to design a healthy diet. Social and Economic Simulations (CS-3204) allows students to experiment with a micro-computer version of the well-known "Limits to Growth" project in Limits or compete against each other in the bicycle industry in Market; U.S. Pop lets students investigate demographic concepts.

The series is designed for the 16K TRS-80 Level II and is attractively packaged in a vinyl binder. Included is a study guide which relates the material to current

"In the classroom, this should be an ideal learning tool. Not only can students work on the mathematical effects of population growth but they can also see the social and ecological effects of any decisions they make..."

"The manual is extremely well done. It provides necessary background information on each program and encourages the student to think about the social aspects of each program rather than just the mathematical processes."

80 Software Critique on
Ecology Simulations-1
Jan-March 1980

Ecology Simulations-2



Rats



Malaria

controversies, stimulates classroom discussion, and provides sample exercises. The series is also available on disk: Ecology Simulations-1 (CS-3501), Ecology Simulations-2 (CS-3502), and Social and Economic Simulations (CS-3508). At a modest \$24.95 each, with quantity discounts available, the series becomes an affordable necessity.

Apple Gradebook (CS-4506) brings the speed and accuracy of the computer to the teacher's traditional grading and record-keeping procedures. Gradebook stores and maintains all student records on disk. The package includes ten interlocking programs which lead you step by step, through setting up a class file and storing it on disk. These invaluable programs summarize the state of the class as a whole and then let you

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Apple III prices range from \$4,340 to \$7,800.

First Two Packages

The Information Analyst consists of an Apple III with 96K bytes of random access memory. It comes with a built-in 5 1/4" floppy disk drive, an integrated keyboard with a 13-key numeric keypad, two built-in printer interfaces and a 12" black-and-white video monitor. Its software includes Apple's Sophisticated Operating System as well as management-oriented tools such as VisiCalc III, Mail List Manager and Apple Basic for \$4,340.

The Word Processor system consists of an Apple III with 96K bytes of memory, integrated keyboard, printer interfaces and a 12" black-and-white monitor, and it comes with two disk drives—one built-in and one external. The disk drives provide the capacity to store about sixty pages of text per removable floppy diskette.

It comes with a choice of printers: either an Apple Silentype draft-quality thermal printer, (\$5,330) or a letter-quality, daisy-wheel printer (\$7,800). Software for the Word Processor includes Apple's SOS operating system, the word processing application software and a training course.

Options for the two systems packages include up to 32K bytes of additional RAM memory, bringing the maximum to 128K bytes total; additional 5 1/4" floppy disk drives, to a maximum of four per

system; either the Silentype or a letter-quality printer; the use of a standard NTSC color video monitor, an RGB color monitor, or even a standard TV set; input/output cards for interfacing other peripheral devices; and a vinyl carrying case.

The Apple III has emulation capability which lets users run programs developed for the Apple II. It uses an 80-character by 24-line upper/lower case display and has four cursor keys for single keystroke cursor movement.



The Apple III offers a built-in disk controller for handling up to four floppy disk drives. One disk is integrated in the computer and up to three additional may be ordered as options.

An integrated clock/calendar can automatically date and time-stamp files to keep track of updates. The unit has a heavy-duty switching power supply that permits it to handle more peripherals. The reset key is located behind the main keyboard area to prevent accidental system reset. And the entire unit has been designed to comply with new FCC standards on radiated interference.

Many New Features

Many of the benefits of the Apple III are made possible by a new Apple-designed central processor. It features a

superset of the 6502 instruction set, relocatable base page register, relocatable stack, and 128K byte address range.

Peripheral devices request machine attention by interrupting the CPU (which optimizes speed), or the CPU may poll peripherals to see which need attention, minimizing the software required for peripheral control.

The new computer has a built-in, 6-bit, digital-to-analog (d/a) converter which gives high-quality sound for voice or music generation.

Graphics capabilities provide flexible color graphic data handling on the monitor screen, including color text foreground and background modes that are useful for highlighting as well as for high-resolution plotting and graphing.

Two Apple keys permit 'soft' or program-defined functions, so commands can be executed with a single keystroke. An alpha-lock key shifts alphabetical keys (but not numbers or symbols) into their upper case mode for compatibility with the Basic programming language and the terminal requirements of other computers. All keys have a hold-down, auto-repeat feature.

Sophisticated Operating System

The Sophisticated Operating System (SOS) ties together the hardware and software features of the Apple III while isolating users from details of system operation. It is the foundation upon which other software is built.

There are four elements to SOS: a file system, a device module, an event management interface, and a memory management system. The file system is byte-oriented and interrupt-driven, and controls storage elements of the Apple III. The device module handles both block-oriented devices (such as disk memories), and character-oriented devices (such as keyboards). The event manager associates interrupts with the activities of an outside source. The memory manager programs to run anywhere there is sufficient memory, thus making memory management transparent to the operator.

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TERMINALS & I/O

IMPACT PRINTER



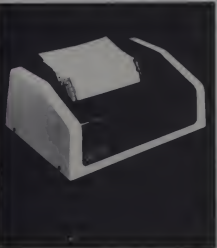
Coosol announces a low cost 88-column tractor feed dot matrix impact printer available in kit or assembled.

Primary features include: microprocessor controlled and programmable with 32 system level commands, graphics, 96 ASCII characters with upper and lower case, print with 9 software selectable sizes from 5 x 7 to 10 x 7 and 10 x 14 character fonts, standard parallel and serial interface, baudrate selectable from 110 to 9600 baud, and adjustable tractor width for paper size selection. Kits, \$445; assembled, \$485.

Coosol Inc., 1585-200 Adams Ave., Costa Mesa, CA 92626. (714) 545-2216.

CIRCLE 226 ON READER SERVICE CARD

VECTOR GRAPHIC PRINTER



A low-cost dot matrix printer has been introduced by Vector Graphic, Inc.

In addition to its speed and high level of graphic capability, the Vector Graphic MP features quiet operation and a 5 x 7 dot matrix software driven printhead.

Base price of the printer is under \$1,000.

Vector Graphic, Inc., 31364 Via Colias, Westlake Village, CA 91361. (213) 991-2302.

CIRCLE 227 ON READER SERVICE CARD

PRINTER INTERFACE FOR PET

TNW Corporation announces the TNW-1000, a printer interface for the Commodore PET/CBM which provides an output-only serial port to interface to current-loop as well as standard RS-232 printers and other devices.



The user can set the TNW-1000's baud rate over the range from 110 to 9600 bits per second, and can switch select automatic conversion from PET to ASCII character sets for either new or old style PET, data word length and parity (8 bit words without parity or 7 bit words with even or odd parity), and IEEE bus address. \$219

TNW Corporation, 3351 Hancock St., San Diego, CA 92110. (714) 225-1040

CIRCLE 228 ON READER SERVICE CARD

COMPUTER/TYPEWRITER INTERFACE



A typewriter interface designed to generate hard copy directly from a computer through any electric typewriter with powered carriage return has been announced by Rochester Data, Inc.

The L/O Pak consists of an array of coils positioned in the same pattern as the typewriter's keyboard which fits directly over the keyboard.

Rochester Data provides interfaces and software for the TRS-80 Level I and II, Apple II and a 6 bit parallel interface for general operation with other computers. The basic L/O Pak retails for \$469. The interface board and power supply are \$145.

Rochester Data, Inc., 3100 Monroe Ave., Rochester, NY 14618.

CIRCLE 229 ON READER SERVICE CARD

PERIPHERALS

Z-80 SOFTCARD FOR APPLE

Microsoft Consumer Products announces the Z-80 SoftCard, a plug-in processor for the Apple II that allows the Apple to run software written for Z-80 based computers.

In addition to the plug-in card, the SoftCard package includes the CP/M operating system from Digital Research and Microsoft Disk Basic, ready to run on the Apple II.

It allows the user to use either the Apple's 6502 processor or the Z-80 processor as needed to run a program. A command is used to switch between the two processors.

The Z-80 SoftCard will run on all configurations of the Apple from the standard Apple II to the Apple II Plus with Language Card. No hardware or software modifications of any kind are required to install the SoftCard. \$349.

Microsoft Consumer Products, 10800 Northeast Eighth, Suite 507, Bellevue, WA 98004. (206) 454-1315.

CIRCLE 230 ON READER SERVICE CARD

HOME CONTROL FOR TRS-80

Popular Computing, Incorporated announces a computer controlled Lighting and Appliance Control System for the TRS-80.

The system is a modified version of the BSR X-10 Home Control System which allows the TRS-80 to control lights and appliances throughout a home or office. Command signals are transmitted over existing house wiring. \$99.95.

Popular Computing, Inc., P.O. Box 16875, Ft. Lauderdale, FL 33318.

CIRCLE 231 ON READER SERVICE CARD

FLOATING POINT PROCESSOR BOARD FOR APPLE

Increased computational speed is now available for the APPLE II.

The Computer Station Am9511 Fast Floating Point Processor Board plugs directly into the Apple II and relieves it of the task of doing transcendental functions in software by using a special version of the standard floating point Basic called Applefast which allows the user to run existing programs with no modification.

Computer Station, 12 Crossroads, Granite City, IL 62040. (618) 452-1860.

CIRCLE 232 ON READER SERVICE CARD



\$1295

Dual Eight Inch Floppy Disk Drives.

Complete with power supply and all necessary cabling. Operates with single or double density controllers for up to 1 megabyte disk storage.

6400 bits-per-inch 48 tracks-per-inch 7msec track-to-track access time 500,000 bit-per-second transfer. Beige cabinet, 5" x 17" x 20 1/4"

Don't look now, but I think there's a wolf crying.

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CIRCLE 133 ON READER SERVICE CARD

DISK DRIVE WOES? PRINTER INTERACTION? MEMORY LOSS? ERRATIC OPERATION? DON'T BLAME THE SOFTWARE!



- Power Line Spikes, Surges & Hash could be the culprit! Floppies, printers, memory & processor often interact! Our unique ISOLATORS eliminate equipment interaction AND curb damaging Power Line Spikes, Surges and Hash.
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 - *SUPER ISOLATOR (ISO-3), similar to ISO-1A except double filtering & Suppression \$85.95
 - *ISOLATOR (ISO-4), similar to ISO-1A except unit has 6 individually filtered sockets \$96.95
 - *ISOLATOR (ISO-5), similar to ISO-1A except unit has 3 socket banks, 9 sockets total \$79.95
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CIRCLE 142 ON READER SERVICE CARD

SAVE ^{ON ADD-ONS FOR} APPLE® AND TRS-80®

NEWDOS/80

Powerful Disk Operating System for the TRS-80® designed for the sophisticated user and professional programmer.

NEWDOS/80 is not meant to replace the present version of NEWDOS 2.1 which satisfies most users, but is a carefully planned upward enhancement.

- New BASIC Commands with variable record lengths up to 4095
- Mix or match drives 35, 40, 77K
- Security lock-up for BASIC or machine code application programs.
- Improved editing commands.
- Enhanced RENUMBER that allows relocation.
- Device handling for routing to display and printer simultaneously
- CDE function: linking of C, D, and E keys allows user to enter a mini-DOS
- Compatible with NEWDOS and TRSDOS 2.3
- Supertop 3.0 and 2.1 utilities

LIMITED UPGRADE OFFER

NEWDOS owners up-grade to NEWDOS/80. Contact Apparat or MTI for information.

NEW DOS FOR APPLE® "APEX"

The complete APEX package with operating system, assembler, editor and user manuals. The package also includes a complete set of utilities to maintain files on single or multiple drive systems. (Specify 3 inch Apple disk or 8 inch disk)

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MTI APPLE II® DISK DRIVE SYSTEM

*One Shugart SA 800R Floppy Controller, Cable and DOS Only

\$1405

DISK DRIVE SALE!

\$70 worth of free merchandise with purchase.

- Shugart SA400 with power supply and chassis \$369
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- TF-5 MPI D51, 40 track \$369
- TF-70 Micropolis, 77 track \$629
- IDH-1 Dual sided, 35 track \$499
- MAX Disk 2, 10 Megabyte \$699

TRS-80® SOFTWARE

- NEW DOS+ 35 track \$99
- AIA Word Processor \$89
- AIA Business Program \$269
- Disk Drive Alignment Program \$109
- Radix Data Base Program \$99.95

MOD I "8" DISK SYSTEM

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- 2 Drive Chassis and Power Supply

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| Cenitronics 701.1 | \$1795 | 702.2 | \$1995 |
| Spurwriter NEC | | | \$1550 |
| Dase 2 Printer 80, 132 cpl graphics / readers | | | \$ 399 |

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CIRCLE 181 ON READER SERVICE CARD

DIGITAL PLOTTER



Mauro Engineering introduces a multi-format digital plotter.

The MP-250 PROAC pen plotter uses standard 8 1/2" x 11" or 11" x 17" paper. It plots at speeds to 2.5 inches per second with .005 inch resolution.

The standard machine uses one parallel output port and comes with full vector driver software for 8080, 8502, and 6800. Interfaces are available for TRS-80, Apple, and serial data ports \$850.

Mauro Engineering, Route 1, Box 133, Mt. Shasta, CA 96067. (916) 928-4406.

CIRCLE 233 ON READER SERVICE CARD



HOME CONTROLLER FOR APPLE

Soft-Sonic is a collection of programs for home control for use with the Apple computer and a BSR Ultrasonic System 10-X. The package includes transducer hardware, interface cable, and software on diskette.

The provided programs allow for control of lighting, appliances, etc., through user defined timed sequences (Applesoft) or by voice command using Hueristics Speech Lab (Integer Basic). \$39.95.

B.A.C.E., P.O. Box 52785, Atlanta, GA 30355.

CIRCLE 234 ON READER SERVICE CARD

MUSIC SYNTHESIZER FOR H-8

Heath Company, has introduced a music synthesizer system for the Heath-kit H-8 Computer. The HA-8-2 Music Synthesizer System includes a circuit board, which plugs directly into the bus of the computer, and the necessary system software, supplied on a standard 5 1/4" floppy disk.

The synthesizer board, which connects directly to any stereo system with the two shielded cables included, produces an excellent 27.5-8,600 Hz fundamental frequency response with up to 9 harmonics. \$159.

Heath Company, Dept. 350-290, Benton Harbor, MI 49022.

CIRCLE 235 ON READER SERVICE CARD

MUSIC FOR TRS-80



Newtech Computer Systems introduces the Music Box, a complete hardware/software tool that enables the user to produce music and sound effects on a TRS-80.

It plays up to four notes at a time with a seven octave range.

The Music Box plugs directly into the TRS-80 keyboard or the Expansion Interface Bus Extension. It includes a volume control, a 400 milliwatt power amp, and phono jack for connection to an external speaker. Software is supplied on Level II cassette. It requires a 32K RAM. \$249.

Newtech Computer Systems, Inc., 230 Clinton St., Brooklyn, NY 11201. (212) 625-6220.



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CIRCLE 128 ON READER SERVICE CARD

TARBELL HAS HIGH-QUALITY S-100 HARDWARE

Part No.	Description	Price
VDS-M	8-slot Mainframe with room for 2 8" floppies	1000.00
VDS-II	Single-Density Single-Sided Floppy Subsystem	2285.00
VDS-IIMDD	Mainframe above with 2 Double-Sided 8" floppies, double-density interface, CP/M, Tarbell BASIC	2999.00
NEH-12K-ASM	32K fully-buffered static memory AS	725.00
NEH-16K-ASM	16K fully-buffered static memory AS	440.00
NEH-OK-ASM	16K fully-buffered static board without memory IC's	240.00
CI-KIT	1500 baud bi-phase Cassette Interface Kit	120.00
CI-ASM	1500 baud bi-phase Cassette Interface AS	175.00
FDI-KIT	Universal Single-Density Floppy Interface Kit	225.00
FDI-ASM	Universal Single-Density Floppy Interface AS	325.00
DD-ASM	Double-Density DMA Floppy Disk Interface AS	495.00

TARBELL HAS HIGH-QUALITY 8080/8085 SOFTWARE

Part No.	Description	Price
CPW-1.4	Floppy Disk Operating System for our interfaces	100.00
CPW-2.0	Extended Version of above Operating System	150.00
MPH	Multi-User Version of above Operating System	400.00
TBAS-CAS	Tarbell Cassette BASIC (uses 24k)	72.00
TBAS-DSK	Tarbell Disk BASIC (uses 24k)	72.00
SPLR	KLM Systems Spooler for CP/M 1.4 on disk	70.00
FAST	Screen-Oriented Editor/Assembler for CP/M	100.00
TELE-COM	Telecommunications Support System	195.00
POLYVUE	Screen-Oriented CP/M Editor	135.00
PASCAL/NT	Meta-Tech Pascal Compiler for CP/M	99.95

Prices are subject to change without notice.
CP/M is a registered trademark of Digital Research.

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(213) 538-2254

CIRCLE 206 ON READER SERVICE CARD

DIRECT CONNECT MODEM FOR TRS-80

Emtrol Systems, Inc. has introduced Lynx, a new direct connect telephone modem designed for the TRS-80 micro-computer.

Lynx comprises a total telephone linkage system in one package, eliminating the need for a separate expansion interface, interface board, telephone coupler and communications software.

It connects directly with the TRS-80 keyboard and the telephone line and includes originate and answer capability \$239.95.

Emtrol Systems, Inc., 1262 Loop Rd., Lancaster, PA 17604.

CIRCLE 236 ON READER SERVICE CARD

HI-RES GRAPHICS FOR TRS-80

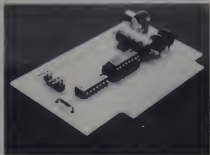
The 80-Grafix Board from Programma International offers high resolution screen capability for the TRS-80.

80-Grafix provides an effective screen of 384x192 plus lower case characters.

Programma International, Inc., 3400 Wilshire Blvd., Los Angeles, CA 90010. (213) 384-0579.

CIRCLE 237 ON READER SERVICE CARD

APPLE MUSIC SYNTHESIZER



American Micro Products, Inc. has announced a music synthesizer designed to plug into any 48K Apple computer using Applesoft Basic.

The "Juke Box" produces three simultaneous voices and one channel of white noise.

Pitch, rhythm, tempo, attenuation and envelope, can be selected and controlled for each voice independently from the other channels. It has a five octave range starting at 55 Hz to 1760 Hz. Each card has an on-board amplifier capable of directly driving an eight ohm speaker. \$129.95.

American Micro Products, Inc., 705 N. Bowser, MS 107, Richardson, TX 75080. (214) 238-1815.

CIRCLE 238 ON READER SERVICE CARD

S-100 DIGITAL SYNTHESIZER



An S-100 based digital synthesizer has been developed by Casheab. The device consists of a synthesizer card and a controller card.

The synthesizer card is responsible for generating the music waveforms. All parameters are loaded into the synthesizer from the host processor, which has control over frequency, waveform, amplitude, and frequency modulation of each channel.

The controller card controls the synthesizer card, summing the channel waveforms and handling the digital-to-analog conversion.

The CP/M compatible floppy disk includes a waveform creation program, a score compiling program and a play program. \$1095.

Casheab, 5737 Avenida Sanchez, San Diego, CA 92124. (714) 277-2547.

CIRCLE 239 ON READER SERVICE CARD

TV PROJECTOR KIT Only \$17.95

Imagine playing computer games or watching TV shows on a giant 5' x 6' screen. Picture quality is as good as giant screen TV's costing over \$1500. The projector is easily built in an hour using inexpensive materials. No modification is needed to your TV. The image is enlarged up to 15 times on the wall or a movie screen. A precision lens and illustrated plans are included. No special tools are needed. The projector is guaranteed to please you or return the kit for a full refund. To order, write "PROJECTOR KIT" on a piece of paper and send it with \$17.95 to:

WDB COMPUTER PRODUCTS
520 Second Street
Graham, Texas 76046

CIRCLE 199 ON READER SERVICE CARD

What you 'C' is what you get!

C Compiler for CP/M

New, and available now! An easily affordable compiler incorporating most of the features of the full C language.

BD SOFTWARE

System requirements: CP/M and at least 24K of RAM

Variable Types: char, int, unsigned

Composite Types: arrays, structures, unions

Pointers: to variables, structures, unions and functions

Features: is a structured language, all functions (Programs) recursive, more powerful expression operators than any other von Neumann type language; allows free formatted source; close enough to UNIX™ C to make conversions feasible.

Speed: On 2 MHz 8080, the statement for (i=1; i<30000; i++) x=x+5; takes about 4 seconds to execute.

Package contains: compiler, linker, library manager; standard function library; sample source files include games, a terminal emulator with disk I/O plus the source for many standard library functions; BDS C User's Guide; Book—The C Programming Language by Dennis Ritchie and Brian Kernighan of Bell Labs.

Recipient of the Computer Lib Seal of Approval

Price: \$125

*CP/M is a trademark of Digital Research Corp.

**UNIX is a trademark of Bell Laboratories.

Source: Software Development, Inc. 4000 Campus Drive, Suite 200, San Diego, CA 92161. A subsidiary of BD, and not affiliated with, or owned by, the publisher.

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2248 Broadway, New York, NY 10024 • (212) 580-0082 Telex: 220501

CIRCLE 190 ON READER SERVICE CARD

CORVUS MULTIPLEXER



A multiplexer has been announced by Corvus which can transform two to 64 personal computers into an interactive multi-user network sharing high speed access to up to 40 million bytes of Corvus hard disk capacity.

Called the Constellation, it is of particular interest for the many business and educational applications now limited to one dedicated computer and a small data base. In addition to sharing open or secured access to the large Corvus data base, computers in a Constellation network can share peripherals, such as a common printer, and communicate in a fully interactive mode.

The Constellation is compatible with the Apple, TRS-80 Models I and II, S-100 Bus, Altos, and LSI-11.

Price of the multiplexer is \$750. Interfaces for the computers in the network are \$235 each.

Corvus Systems, 2029 O'Toole Ave., San Jose, CA 95131. (408) 946-7700.

CIRCLE 240 ON READER SERVICE CARD

COMPUTERS

MODULAR S-100 SYSTEM

CSN Inc. announces its System 1000 family of microcomputers: a modular, bus-oriented line of systems organized around the IEEE S-100 Standard bus.

The S/1000 includes a 4Mhz Z80A processor, 64K RAM, 8" Winchester-technology hard disk, cartridge tape data backup, a variety of I/O devices and other peripherals, a choice of hardware options, and expansion capability to 18-bit processors.

Operating systems for the S/1000 include Digital Research CP/M 2.0 and CSN PDOS, a literal superset of CP/M 1.4. Software compatible with these operating systems includes languages such as Basic, Pascal, Cobol, Fortran, and C; business and financial packages; database management systems and word processors.

CSN Inc., 120 Boylston St., 4th Floor, Boston, MA 02116. (617) 482-2343.

CIRCLE 241 ON READER SERVICE CARD

SMALL BUSINESS SYSTEM

The Microstar system is designed as a multi-user, multi-language micro-computer. The package consists of a single-board computer with 64K bytes of main memory, and 2.4 megabytes on two 8" floppy discs.

The prime operating system is STARDOS (Basic) supporting indexed sequential files, direct files, and sequen-

tial files. CP/M is also supplied with the system, and will operate with Northstar Basic, Microsoft Basic, and all associated machine languages.

The system will allow two simultaneous users, although the second CRT terminal is extra. The printer is a 150cps, 9x7 dot matrix, handling both 80 and 132 column commands, plus expanded type printing under software control, bi-directionally.

General ledger, payroll, accounts receivable, word processing and order entry. Software is included. \$10,995.

Parke-Randall Corporation, 12218 Morrison St., North Hollywood, CA 91607.

CIRCLE 242 ON READER SERVICE CARD

HOME BUILDER'S BUSINESS SYSTEM



Dalcon International, Inc., has introduced its Home Builders Business System, a turnkey, microcomputer system consisting of a North Star Horizon II computer, video terminal and printer.

The system does complete job costing, allowing each house under construction to be broken down into up to 99 user definable cost centers. It also provides a general ledger which keeps track of accounts payable to vendors and subcontractors as well as providing financial statements.

Dalcon International, 511 Woodbine Ave., Nashville, TN 37211. (615) 242-5801.

CIRCLE 243 ON READER SERVICE CARD

3D DIAGRAMS

Have you ever looked at a diagram on flat paper and tried to imagine what it is supposed to represent in real three dimensional space? If you have you will love this program. With "3D Diagrams" you can make diagrams that look real—they stand right up off the page. 3D DIAGRAMS is a program listing—don't worry. It is not too long to type and it is written in standard BASIC and will run on any BASIC computer. (TRS-80, PET, APPLE, etc.) Along with the listing you get everything you need to make any 3D diagram plus a clear explanation and easy to understand instructions. Send your \$10.00 (U.S.) check or money order now! Distributed by:

Peter R. Spenier
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Canada N6A 3C9

CIRCLE 168 ON READER SERVICE CARD

The "DATA DUBBER"

DUPLICATES ANY
PROGRAM TAPE

TRS-80

Yes, even those in machine language! Feed your cassette into the "Data Dubber" and get out exact replicas of the TRS-80 CSAMP data pulses. Obtain perfect CLORD even from tapes with hum, distortion, or minor dropouts... and without constantly adjusting the volume. Connect a second cassette to the "Data Dubber" and make perfect reproductions, just as if the data had come from the TRS-80.

The "Dubber" works with Level I or II and costs only \$49.95 postage paid. Start your own software business. Pays for itself in time saved and reduced tape cost. Order the "Data Dubber" today! If you are not completely satisfied with its performance simply return it for full refund.

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CIRCLE 200 ON READER SERVICE CARD



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SOMETIMES COUGH, SNEEZE OR
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Add \$1.50 shipping & handling delivery from stock

Omni Communications Co., Inc.
Jackson, New Jersey 08527

CIRCLE 174 ON READER SERVICE CARD

DISK SYSTEMS

HARD DISK FOR NORTH STAR

North Star Computers Inc. has announced a Winchester-type 18Mb hard-disk enhancement for its Horizon computers. A unique method is used for backing up the information stored on the disk: the information that is modified each day is backed up on floppy disk, on a sector-by-sector basis.



The drive consists of the 18Mb Winchester-technology hard disk, enclosure, power supply, controller, cables and software. Software includes a hard disk operating system (HDOS), North Star Basic and back-up and recovery facilities.

North Star Computers, 1440 Fourth St., Berkeley, CA 94710. (415) 527-8950.

CIRCLE 244 ON READER SERVICE CARD

"Attention Computer Owners"

If you own a mini or micro...you could be on your way to fantastic riches. Put your computer to a new use by monitoring these investments. Set up your own office in your home...never work for the other guy again. It is the most ingenious method ever devised. Make six digits annually.

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Ashland, Ohio 44805

CIRCLE 114 ON READER SERVICE CARD

THIS MONTH'S SPECIALS

SPECIAL #1

If you purchase the "TRS-80 DISK AND OTHER MYSTERIES" Book for the regular price of \$22.50 you can buy 10 VERBATIM DISKETTES

AND a plastic library case for \$22.00
TOTAL \$44.50

*** FREE SHIPPING FOR ORDERS OVER \$20.00 ***

SPECIAL #2

If you purchase APPARAT NEWDOCS— for the regular price of \$99.95 you can buy 10 VERBATIM DISKETTES

AND a plastic library case for \$5.00
TOTAL \$104.95

* VERBATIM DISKETTES \$26.50

or the best price you find minus \$500

* PLASTIC LIBRARY CASE \$2.50

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St. Louis, Missouri 63103

(314) 862-8504

CIRCLE 104 ON READER SERVICE CARD

JULY 1980

HEATH FLOPPY DISK ACCESSORY FOR H89



Heath Company has introduced a floppy disk accessory for its Heathkit H89 Computer.

The H-77 Floppy Disk System uses standard 5 1/4", hard sector 40-track diskettes. Each diskette is capable of storing 100K bytes of data.

The H-77 Floppy Disk System, mail order priced at \$595 in kit form, includes one disk drive. The H-17-1 Disk Drive, mail order priced at \$325, is available to provide two-drive capability for the H-77.

Heath Company, Dept. 350-280, Benton Harbor, MI 49022.

CIRCLE 245 ON READER SERVICE CARD

TRS-80 DUAL DISK DRIVE

Computhink, Inc. has introduced a TRS-80 compatible dual disk drive with a capacity that is equal to four Radio Shack disk drives.

The single density, dual-head 5 1/4" minifloppy drives provide 400K bytes of on-line storage capacity by recording on 40 tracks per side.

The plug-compatible dual disk drives utilize the TRS-80 disk controller and are compatible both with the TRS-80 Disk Operating System and standard Radio Shack diskettes. \$1295.

Computhink, 965 West Maude Ave., Sunnyvale, CA 94088, (408) 245-4033.

CIRCLE 246 ON READER SERVICE CARD



TELEPHONE PROGRAM FOR TRS-80

- | | |
|---|-----------------------------|
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| 2. Audio manual and drive status | 6. Binary editor |
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173

SYSTEMS SOFTWARE

LANGUAGES

PCD Systems, Inc. announces the release of **USCD Pascal** for the TRS-80 Model II. The standard package includes an interactive operating system with run time support routines, P-code interpreter, compiler, screen editor, character oriented editor, Z-80 macro assembler, linking loader, patch/dump utility program and other utilities. \$380. PCD Systems, Inc., P.O. Box 143, Penn Yan, NY 14527. (315) 536-3734.

CIRCLE 247 ON READER SERVICE CARD

Business Microproducts announces the **Nevada Cobol** compiler for the TRS-80 Model I and II, which translates source language programs into machine language programs. The compiler, run time package, sample Cobol program and terminal configuration program are supplied on a CP/M data diskette. \$99. Business Microproducts, Livermore Financial Center, 1838 Catalina Ct., Livermore, CA 94550. (415) 443-4876.

CIRCLE 248 ON READER SERVICE CARD

Lisp/80 is a full implementation of Lisp 1.5. Supplied on 8" single density floppy disks for CP/M users, it offers pattern matching and recognition, robot simulation, game playing programming, general problem solving and natural language processing. \$75. T.W. Yonkman, 4182 Caminito Islay, San Diego, CA 92122.

CIRCLE 249 ON READER SERVICE CARD

SYSTEMS

Microsoft Consumer Products announces a **Basic Compiler** for the TRS-80 which compiles programs written with the TRS-80 disk Basic interpreter, producing Z-80 machine

code that is directly executed by the TRS-80. The package includes two diskettes containing the Basic Compiler, Basic run time library and Link-80 linking loader; instruction manual and reference manual for Microsoft 5.0 Basic. \$195. Microsoft Consumer Products, 10800 Northeast Eighth, Suite 507, Bellevue, WA 98004. (206) 454-1315.

CIRCLE 250 ON READER SERVICE CARD

The **Optimized Systems Software** Group announces a disk-based operating system package for the Apple II. The complete package consists of CP/A (Control Program/Apple), including a set of disk utility commands similar to those of the 8080-based CP/M, and fully compatible Basic, Text Editor, Assembler and 6502 Debug programs. \$89.95. Giepardson Microsystems, Inc., 20823 Stevens Creek Blvd., Bldg. C4-H, Cupertino, CA 95014. (408) 257-9900.

CIRCLE 251 ON READER SERVICE CARD

LSPOOL is a line printer spooling facility for the TRS-80 which permits concurrent printing in the foreground while normal TRSDOS operation continues in the background. A two-disk 32K or 48K system is required to support the 3K assembler program. \$39.95. Automated Resource Management, Inc., P.O. Box 4553, Irvine, CA 92716. (714) 983-2976.

CIRCLE 252 ON READER SERVICE CARD

Altair CP/M from Lifeboat Associates is implemented on the Altair 8800 and MITS 3202 series of floppy disk systems and allows users to take advantage of the 800K capacity per disk, and gives them access to the broad range of systems and applications software available. \$145. Lifeboat Associates, 2248 Broadway, New York, NY 10024. (212) 580-0082.

CIRCLE 253 ON READER SERVICE CARD

EDAS 4.0 from Galactic Software is a RAM-resident text editor and assembler for the TRS-80 Model II. The editor provides text editing facilities for the modification of alphanumeric text files. The assembler portion facilitates the translation of Z-80 symbolic language source code programs into machine executable code. \$229. Galactic Software Ltd., 11520 North Port Washington Rd., Mequon, WI 53092.

CIRCLE 254 ON READER SERVICE CARD

TED is an advanced editor for microcomputers which implements a large subset of commands from TECO, an advanced editor which DEC supplies with its minicomputers. Its features include sophisticated macro structures, iterative and conditional execution of commands, 36 command/text buffers and a 32-entry push-down stack. TED runs on Z-80 systems supporting CP/M. \$90. Small System Design, P.O. Box 4546, Manchester, NH 03108. (603) 432-7929.

CIRCLE 255 ON READER SERVICE CARD

The **Taskmaker** enables users of North Star Basic and CP/M to combine the power of both. It offers North Star owners dynamic file extension and creation, automatic reclamation of deleted files and all other features of the CP/M operating system. \$89.95. The Sofio Group, 140 Thompson St., Suite 4-B, New York, NY 10012.

CIRCLE 256 ON READER SERVICE CARD

The **Advanced Application Development System** for the TRS-80 Model II includes a data base handler, display control monitor, indexed sequential file support, advanced executive language, high speed Basic compiler/interpreter, commercial-level operating system and documentation support. The Software Firm, Inc., P.O. Box 6267, Denver, CO 80206. (303) 778-7473.

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CIRCLE 211 ON READER SERVICE CARD

Wintek announces a C compiler for the 6800 microprocessor which is intended to run under the Wizard multi-tasking disk operating system on the Sprint 68 microcomputer. \$4.95. Wintek Corporation, 1801 South St., Lafayette, IN 47904. (317) 742-8428.

CIRCLE 258 ON READER SERVICE CARD

RSMMI is a machine language monitor for the TRS-80 Model II. It has all the features developed for the Model I plus a video editor for examining and modifying both memory and disk sectors. \$39.95. Small System Software, P.O. Box 366, Newbury Park, CA 91320.

CIRCLE 259 ON READER SERVICE CARD

DATA BASE PACKAGES

Database Two is a data base management system written in Micropolis Basic for the TRS-80 Model II. It allows the user to create, maintain, add, edit, delete, sort, search, inspect and print data files of up to 1200 entries each. \$125. Bonjoel Enterprises, P.O. Box 2180, Des Plaines, IL 60018. (312) 297-2921.

CIRCLE 260 ON READER SERVICE CARD

APPLICATIONS SOFTWARE

RECREATIONAL GAMES

Parsector V is a space war game for the TRS-80 Level II computer in which two players plot their strategies using private video displays hidden from their opponents. The game features a split screen display format and instructions for building a cardboard screen divider hood. \$19.95. Synergistic Solar Inc., P.O. Box 560596, Miami, FL 33156.

CIRCLE 261 ON READER SERVICE CARD

The Stone of Sisyphus is the second game in the Magic series of role-playing adventures for the TRS-80. It allows the player to create, outfit and use characters to explore a subterranean world of monsters, magic, traps and treasures. Chameleon Software, Inc., 4733 N. Mitchner, Indianapolis, IN 46226.

CIRCLE 262 ON READER SERVICE CARD

Electra Sketch for the TRS-80 is an animation and graphics compiler with which the user can create a picture frame using one-key commands to control cursor direction, draw, erase, draw vectors, fill in backgrounds with any sequence of characters, save on disk or recall from disk. Macrotronics, 1125 N. Golden State Blvd., Suite G, Turlock, CA 95380.

CIRCLE 263 ON READER SERVICE CARD

The Allen Music Box 1 series for Commodore microcomputers features compositions by Bach, Chopin, Mozart and Sousa. In the **Allen Animation 1** series music is combined with animated figures on-screen. Both run on 8,16, and 32K PETS. \$10. Allen Computer Products, Box 2283, Livonia, MI 48151.

CIRCLE 264 ON READER SERVICE CARD

Wumpus Adventure for the Atari 800 combines two of the most popular computer games and adds color graphics and sound effects. \$14.95. Sebree's Computing, 456 Granite Ave., Monrovia, CA 91016. (213) 359-8092.

CIRCLE 265 ON READER SERVICE CARD

Dungeons is a fantasy adventure for the OSI in which the player takes the role of a fighter, dwarf, halfling, elf or magic-user in search of gold in the unexplored dungeons beneath the Wizard's city or in the forest surrounding it. \$12.95 for cassette or \$15.95 for disk. Aurora Software Associates, 353 S. 100 E. #6, Springville, UT 84663. (801) 533-9002.

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CIRCLE 187 ON READER SERVICE CARD

Aresco, Inc. announces Kim-Venture, an adventure game for use on a standard 1K Kim-1 Microcomputer. The package contains a Kim cassette, a 32-page operator's manual and three pages of player instructions. \$24.95. Aresco, Inc., P.O. Box 1142, Columbia, MD 21044. (301) 730-5186.

CIRCLE 267 ON READER SERVICE CARD

Soundware includes the software and hardware necessary to allow the user to make music and sounds on the Compu-color II. \$49.95. Compucolor Corporation, 225 Technology Park/Atlanta, Norcross, GA 30092.

CIRCLE 268 ON READER SERVICE CARD

EDUCATIONAL

Super-CAI for the TRS-80 is an expanded version of CAIware with the following additional features: menu option six is implemented in the CAI-Author program, providing the capability to review and modify lesson screens on tape; the CAI-Copy program is provided for backing up CAIware lesson tapes and improving performance by means of data compression. \$64.95. CAI-2D is a disk version of Super-CAI with the added capability of composing tests from a databank of questions, and maintaining student performance records on disk. \$125. Micro-Gnome, 5443 Montgomery Rd., Elkridge, MD 21227. (301) 796-4165.

CIRCLE 269 ON READER SERVICE CARD

A Management Simulation Game based on games played at graduate business schools by teams of managers is now available in North Star Basic. Each player or team controls a company manufacturing three products and competing against other companies, each of which sells three similar products. Certified disk, \$17.50; hardcopy listing, \$12.50. GIGA, P.O. Box 1881, Chicago, IL 60690.

CIRCLE 270 ON READER SERVICE CARD

Educational Activities, Inc. announces programs for math, language arts, spelling and class management. Introduction to Math on the Computer, Introduction to Decimals on the Computer and Missing Math Facts cover several levels of difficulty and are self-scoring. There are 16 Language Arts programs dealing with nouns, pronouns, verbs, adjectives, adverbs, homonyms, synonyms, antonyms and contractions. Spelling programs include Scrambled Letters and Flash Spelling. The class management programs are Readability Index, which enables the teacher to determine the reading level of any text, and Grade Averages, which calculates students' grade averages by using both numeric and letter grades. Educational Activities, Inc., P.O. Box 392, Freeport, NY 11520. (800) 645-9739.

CIRCLE 271 ON READER SERVICE CARD

Study Quiz Files is a teaching program for the Apple II which enables a teacher to create, save, retrieve, review or run study quizzes on any subject without any programming knowledge. Multiple Choice Files is a similar program for multiple choice tests. Both include randomized questioning and immediate feedback learning strategies. Apple-Cations, 21650 W. Eleven Mile Rd., Southfield, MI 48076.

CIRCLE 272 ON READER SERVICE CARD

The Elementary Math Edu-Disk for the 48K Apple II contains an arithmetic readiness test and four interactive lessons designed to teach elementary addition, subtraction, multiplication and division on nine different skill levels. \$39.95. Muse Software, 330 N. Charles St., Baltimore, MD 21201. (301) 659-7212.

CIRCLE 273 ON READER SERVICE CARD

Language Teacher programs in French, Spanish, German and Italian feature a drill learning format with language-to-English or English-to-language usage options. Each TRS-80 program offers word combinations, phrases and verb conjugation forms. \$19.95. Acorn Software Products, Inc., 634 North Carolina Ave., S.E., Washington, D.C. 20003.

CIRCLE 274 ON READER SERVICE CARD

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CIRCLE 185 ON READER SERVICE CARD

Tycom Associates announces the Educational Software Series for the Commodore PET/CBM computers. The series is available on cassette tape, and includes Algebra (\$19.95), French and Vocabulary (\$15.95). Tycom Associates, 68 Velma Ave., Pittsfield, MA 01201.

CIRCLE 275 ON READER SERVICE CARD

BUSINESS



North Star Computers has announced four application software packages. NorthWord is a word processor which includes easy entry and editing, on-screen text formatting and simultaneous document printing. \$399. MailManager is used to compile and maintain complete organized mailing lists. \$299. InfoManager is a list-oriented information management system which will accept up to 50 categories of information for each record and has the ability to select and sort before printing. \$499. GeneralLedger includes both general ledger and financial reporting programs. It can combine with NorthWord to use the information in the general ledger to produce customized financial statements and reports. \$999. North Star Computers, Inc., 1440 Fourth St., Berkeley, CA 94710. (415) 527-8960.

CIRCLE 276 ON READER SERVICE CARD

The Estimator is a menu-driven program for TRS-80 and CP/M systems which assists the user in preparing and organizing a detailed estimate. Written in Microsoft Basic, it allows entries for the item title, material quantity, unit cost of material, and hours required. Prices start at \$30. The Framing Calculator is designed to assist general contractors, architects, construction estimators and engineers in calculating estimated labor and material requirements for general wood frame construction. Also written in Microsoft Basic, it is available for \$100. Mendocino Software Development, P.O. Box 1564, Willits, CA 95490.

CIRCLE 277 ON READER SERVICE CARD

ACCT-M2 for the TRS-80 consists of five programs that carry out the on-line accounts receivable functions of a small business or medical clinic. Its three basic functions are initialization, data base management and report generation. \$149. Micro Architect Inc., 96 Dothan St., Arlington, MA 02174.

CIRCLE 278 ON READER SERVICE CARD



Your CP/M system just isn't worth its salt...until it's been through a night like this.

The Pirate stands ready to challenge your CP/M system to a battle of wit and endurance. As you traverse uncharted lands and seas, you'll meet up with wild animals, magical beings and a smart alec parrot. Adventureland and Pirate Adventure are two of the most mind-bending game simulations you'll ever encounter (CS-9003) \$24.95.

Original Adventure is an undisputed classic. The treasures you seek are hidden in underground caverns. All you have to do is find them. It's easy. Just overcome a giant clam, nasty little dwarves and other deadly perils. This game is bi-lingual so, to make it really a cinch, just type in "GO FRANCE" and the characters will speak and understand only French (CS-9004) \$24.95.

The Basic Games Library features 190 top-notch simulations, battles and strategy games from the celebrated Basic Computer Games Book and its sequel, More Basic Computer Games. Volume I (CS-9001) and Volume II (CS-9006) include Super Star Trek, Slalom, and Checkers. Each disk is \$24.95. Both disks and the Basic Computer Games Book are available for only \$50.00 (CS-9000).

Volume III (CS-9005) and Volume IV (CS-9006) feature Yahtzee, Tennis, Wumpus and Grand Prix. The disks are \$24.95 each. Both disks and the More Basic Computer Games Book are \$50.00 (CS-9007). The entire four disk collection also includes both big games books, edited by David Ahl, and is \$95.00 (CS-9008). All are on 8" disks, require 48K and Microsoft Basic.

Your local computer store should carry Creative Computing Software. If your favorite retailer does not carry the software you need, have him call in your order to 800-631-8112. Or, you can order directly from Creative Computing. Write to: Creative Computing Software, Dept. AHGG, P.O. Box 789-M, Morristown, NJ 07960. Include \$1.00 for postage and handling. For faster service, call in your bank order toll free to 800-631-8112.

sensational software

CIRCLE 300 ON READER SERVICE CARD

National Software Marketing, Inc. announces **Accounts Receivable, Accounts Payable and General Ledger** programs for the TRS-80 Model II. It accommodates 200 vendors, 500 customers and a chart of accounts of 250. The system is in Basic and operates under the standard TRSDOS operating system. \$150. National Software Marketing, Inc., 4701 McKinley St., Hollywood, FL 33021. (305) 625-0062.

CIRCLE 279 ON READER SERVICE CARD

Data Processing Consultants introduces two packages for the TRS-80 Model I which are designed to allow effective management of a small retail business. A **Balance Forward Accounts Receivable** program keeps track of transactions each month on account, and a **Retail Inventory Control** program keeps track of inventory and sales information on each of 99 departments. **Accounts Receivable** sells for \$200, and **Inventory** sells for \$400. Data Processing Consultants, 304 S. Dunlap, Paris, TN 38242. (901) 642-0127.

CIRCLE 280 ON READER SERVICE CARD

Computer Services of Encinitas supplies the complete line of Osborne business applications programs in CBasic2 for the North Star MicroDisk System. **General Ledger, Accounts Payable, Accounts Receivable and Payroll** programs are custom configured to match the purchaser's disk and terminal. \$125. Also available in North Star Basic are the 97 programs included in the Osborne book **Some Common Basic Programs**. \$25. Computer Services of Encinitas, 341 Willowspring Dr., Encinitas, CA 92024. (714) 436-2486.

CIRCLE 281 ON READER SERVICE CARD

Taranto & Associates announces an **Accounts Receivable/Invoicing System** for the TRS-80 Model II. The system features an open item accounting system, the ability to bill up to 51 items on a single invoice and the ability to calculate service charges. It prints statements as well as invoices. \$249.95. Taranto & Associates, Inc., Box 6073, 4136 Redwood Hwy., San Rafael, CA 94903. (415) 472-2670.

CIRCLE 282 ON READER SERVICE CARD

The Electric Abacus introduces **Real Estate Index and Locator**, a system of Basic language programs designed to assist real estate agencies in finding properties for customers. The interactive search and sort programs match home specifications of a prospective buyer with current active MLS listings. It also provides financial information for the buyer. The program, called **Reiley**, is available for the North Star disk system with a single drive and 24K or memory. The Electric Abacus, 19 Mayfield Rd., Regina, Saskatchewan, S4V 0B7 Canada.

CIRCLE 283 ON READER SERVICE CARD

A CP/M-based **Inventory Control** software package for small to medium sized businesses is able to support up to 32,767 inventory item records, and provides up-to-date, information on the quantity, value, and activity of inventory items. It includes an "auditability option" to create an ongoing hardcopy record of stock additions and depletions.



Structured Systems Group

The system requires CBasic2 and runs on most CP/M systems with dual floppy disk drives and 48K of user memory. **Structured Systems Group**, 5204 Claremont Ave., Oakland, CA 94618. (415) 547-1567.

CIRCLE 284 ON READER SERVICE CARD

Inventory One for TRS-80 Model II consists of ten programs which generate nine basic reports, including inventory, orders, vendor listings, reorder status, receiving, stock locations, parts lists, cost lists and price lists. \$125. Also available is a **Client Billing System** which creates both client data and billing data files. Both systems are compatible with Database Two. **Bonjoel Enterprises**, P.O. Box 2180, Des Plaines, IL 60018. (312) 297-2921.

CIRCLE 285 ON READER SERVICE CARD

Datsmith announces **Payroll and Bookkeeping** software packages written for users of Micropolis Basic. The menu-driven systems are interactive and provide full features with a variety of printed reports. Both require at least 40K of RAM and two disk drives. **Datsmith**, 15501 W. 109th St., Lenexa, KS 66219.

CIRCLE 286 ON READER SERVICE CARD

A **Weekly-Payroll** package for the Apple II requires 32K RAM, two disk-drives and a printer. It handles up to 200 employees identified by name, social security number and address; computes gross pay; derives net pay by computing and deducting applicable taxes; and produces weekly, quarterly and annual employee pay reports. \$185. **NSP, Inc.**, P.O. Box 3092, Crofton, MD 21114. (301) 956-3476.

CIRCLE 287 ON READER SERVICE CARD

Medical Management System, Dental Management System, Real Estate Multi-List, Insurance Agency, Legal Time Accounting, General Ledger, Accounts Payable, Accounts Receivable, Payroll and Inventory from Univair, Inc., are written for the 64K TRS-80 Model II and run in 32K RAM using the latest version of CBasic2. \$495 each. **Univair, Inc.**, 10327 Lambert International Airport, St. Louis, MO 63145. (314) 426-1099.

CIRCLE 288 ON READER SERVICE CARD

Med Pac II for the TRS-80 Model II is a medical billing program that handles all patient and third party billing. It will print up to 40 types of insurance forms and provides control of all invoice data for up to 30 doctors. **VR Data**, 777 Henderson Blvd., Folcroft, PA 19032. (800) 345-8102.

CIRCLE 289 ON READER SERVICE CARD

Graham-Dorian Software Systems introduces a computer software **Dental Package** which handles patient records of charges, payments, insurance, delinquent accounts, and daily and monthly transactions. It prints out patient statements and standard insurance forms for the American Dental Association. The package may be ordered on standard 8" disk or various mini-floppy disks. **Graham-Dorian Software Systems, Inc.**, 211 N. Broadway, Wichita, KS 67202. (312) 265-8633.

CIRCLE 290 ON READER SERVICE CARD

CalData's DentalWare for TRS-80 Model II is a self-contained series of programs for the modern dental practice. Its features include: patient personal, financial and insurance record keeping; treatment plans and work history; fully itemized statements; pass-word access to various commands and complete word processing capability. \$2600. **CalData Systems, P.O. Box 178446, San Diego, CA 92117**.

CIRCLE 291 ON READER SERVICE CARD



Project Schedule Analysis/1 is a cassette-based introduction to computer-aided scheduling for the TRS-80 Level II and Apple II computers with floating point Basic and at least 16K of memory. It uses critical path scheduling techniques to compute schedules for each job within a project. \$25. **Express Marketing, P.O. Box 1736/CCM, Poulso, WA 98370**.

CIRCLE 292 ON READER SERVICE CARD



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GEORGIA

Atlanta Computer Mart—5091 Buford Hwy, Atlanta 30340; (404)455-0647. 10-6 Mon-Sat.

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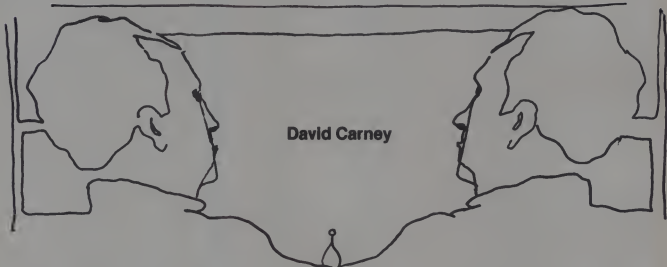
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Too Identified



The whole house is reeking of formaldehyde because Elaine has got a pair of hamster cadavers in the kitchen, dissecting them, researching some point of biology for her thesis, her research being obscure to me, but that formaldehyde has hit me where I live. I take a shower to clear my head, specifically my sinuses, and after I dry and change, I pause in the kitchen on my way out the door.

"I'm going to walk for an hour or so," I say to Elaine, as she is hunched over the corpses, and the wet, pink guts hanging out of them, her face hidden by her masses of uncombed black hair. She is hunched very close because she is so myopic, and doesn't like lenses for close work. "I'm going to vent my olfactory." (You have to know how to talk to these people, I say to myself.)

"Good, I'll be finished by then," she says from under all the hair. "I'll try to burn some incense or something."

I suck in some clear air once I am outside, and pat my breast pocket, I have not forgotten my wallet, containing my money and contour cards, and I head down the driveway taking long strides, reinforced by the clear, wild starscape.

I am aware of a row of beacons slipping off the 495 exit, which is about five hundred meters down Connecticut Avenue from my house. They are police vehicles, and they whip into my drive, no sirens, beacons throbbing. (Not being an epileptic comes in handy sometimes.) I have practiced law for a couple of years, and have heard horror stories about sloppy, unconstitutional police arrests which I love to tear apart in court afterward. I stand with arms folded as a handful of people spill out of the vehicles, producing electric dart launchers and lasers, and I am more curious than intimidated, even

though it is really happening to me, I am being arrested. Why else would they be here, I mean.

"Jacob Silver?" someone asks. There are a total of five officers standing outside a total of three vehicles.

"Yes, I'm Silver. Exactly what do you people want?" What a trite response, I think. I've really been watching too many detective tapes.

"We have a warrant for your arrest," someone says. All the officers are maintaining their positions by their vehicles, no one is moving forward. In the beacon lights, I can't tell who is speaking. I notice several launchers pointed at me.

"You are suspected of grand theft. Put your hands on top of your head so we don't have to shoot you."

"Fascinating," I say. I put my hands on my head, and an officer steps forward to frisk me and cuff me.

"Don't say anything until your rights are read to you," he admonishes.

And I don't. I get led into one of the vehicles, and we hum away. Christ, what a mess, I think, Elaine will probably never allow me to go for a walk again. Maybe it is a formaldehyde hallucination.

Opposite me at the desk in the five by five foot interrogation room is a bald, paunchy detective sucking on an egregious green cigar, a tag on his lapel which says "Vaccara," and he is telling me that he is only asking preliminary questions.

"I haven't looked at the reports of the detectives who are covering the Arlington National robbery. They work the day shift. Maybe I should."

"Is that the specific charge? Robbing the Arlington National?" I say. "Hey didn't there used to be a cemetery—"

"You are charged with grand theft," Vaccara begins, "and specifically, a teller at Arlington who apparently

David Carney, 1105 s, Princeton Ave., Birmingham, AL 35211

has a gift for remembering numbers, happened to remember yours from your contour read-out when you were trying to cash a check this morning, and then proceeded to rob the place."

"Impossible," I assert, incredulous. "I don't have an account there, why would I even go there? Besides, remembering a social security number is no basis for a case—"

"I know," Vaccara smiles deviously, "but you have an Oregon issued social security number. I checked the census records in our computer. Only thirteen people in D.C. have Oregon social security numbers, and only one has one that comes close to yours, and it belongs to a woman."

"Nothing like sticking to fundamentals," I suggest. "Oh yeah," Vaccara sighs, and stands, grabbing the doorknob behind him, "I love my work. Now I guess I better pull the file on the robbery, and I'll be back in a couple of minutes. I think your lawyer is here. He's going to tell you what a dummy you were to talk to us before he got here."

"I don't have a lawyer," I frown. "I am a lawyer." Vaccara rolls his eyes and shrugs. "Then I don't know who this is, you have a mystery guest," he says, and leaves.

Paul Casey brushes by Vaccara and into the interrogation room, dropping wearily into the chair where Vaccara had been, looking at me with cow eyes. Casey works for the D.C. public defender, and we and Elaine play euchre together sometimes, which he has made into a contact sport.

"Elaine called me, Jacob," he recounts solemnly. "She heard you talking in the driveway and watched them take you away. You dope."

"Can it, Paul," I say. "Somebody impersonating me robbed the Arlington Bank."

"Yeah, right."

"I'm not kidding, they must have. I didn't do it." "Allright, now let's consider this," Paul says, gesturing editorially. He rubs his eyes. "What does a person have to do to rob the Arlington Bank? First, one has to get a teller to open her cash drawer—"

"And it won't open until a customer's contour card is matched by the computer. If your facial contours recorded on your card don't match what is being read into the computer by the scanner the teller has on your face, his or her cash drawer won't unlock."

"A pretty substantial circumstantial case," Paul summarizes bleakly. "But I don't see that you're very convictable yet."

"Gee, thanks."

"Now what they have to do, they have to prove that it was your contour card that was in the computer, that it was you who was there. Now the computer doesn't keep records of matches. It just does them, that's enough."

"Yes, but I've been told," I interject, "that there is a teller at the bank who has an unusual facility for remembering numbers, and apparently when I — I mean the thief — was robbing her, he had to leave the card in the computer to keep the cash drawer open, and so the teller just memorized the social security number that was on the read-out monitor with his facial contour. And only one other person in this city has an social security similar to mine, a woman."

"Nonetheless it is merely circumstantial, and you are defendable. May I have the honor?"

"Go counselor, go."

"If there was a record of your contour being fed into the computer at the time of the robbery, which there isn't, they could just get a contour expert to compare the

original contour that the computer has on record with a fresh one that they could make in court, all very dramatic but it won't happen. The matching social security number is all they've got, and even that isn't documented, even if the contour had your name recorded on it, it would be no good to them."

"Maybe it's past your bedtime," I say, "but you've forgotten to ask me something very crucial."

"What?"

"Don't you want to know if I did it?"

"Need I ask at all?" Paul smiles, sarcastic.

I squint at him. "I could take that two ways, you creep."

I start to get very popular. Vaccara reappears in the doorway, and he is yelling back out the door to someone, and has a manila file folder in his hand.

"Bug off, will ya?" he is insisting. "You can see him after we finish processing things. I'm trying to be patient. I could have you escorted out of here."

"I'll be out here," Elaine's voice growls. "You fascist. I'm going to call the Post and the Star. And the networks. You'll have a mob of reporters to contend with in a matter of—"

Vaccara closes the door behind him. "You sure have funny friends," he scowls at me, disapproving. "She sure smells funny."

Vaccara points with his thumb in the air, signaling Paul to concede him the only chair in the room besides mine.

"Oh Christ," Paul says, and squirms to rise and find a place to stand next to the desk, the room becoming crowded.

"O'okay buddy," Vaccara groans and sits, opening his manila folder. "We know now that you didn't do it."

"Oh my God —" I begin.

"Is he released?" Paul snaps. "You can't hold him anymore."

"Don't wet your pants, barrister," Vaccara intones, patiently, even though it is a very sarcastic, incitive question. "What is happening here is bigger than you and me." He turns to me. "You can go, but I'd still like to talk to you. Can I buy you a late dinner?"

As it turns out, Vaccara is buying me and Elaine and Paul Casey dinner. We keep it simple, everyone orders chops and rice.

Vaccara is the only one not digging in, he has the manila file folder poised in front of his face, and he is simultaneously reading it and carrying on a conversation with all of us.

"If you wanted to cover this crime up, officially cover it up," he is saying. "How would you do it?"

There is a general pausing of chewing around the table, and all of us stare at the manila folder with Vaccara behind it.

He closes the folder and places it in front of his plate. "I have been instructed," he explains. "To put a lid on the whole thing. It seems that the police have in custody in Chevy Chase, a man with a computer contour identity card which not only has Mr. Silver's contour on it, but it further has instructions on it which cause the federal identity computers to read out 'match' with whoever's face contour is being read into them. I find it interesting."

"I would say it's fascinating," Elaine says, and resumes chewing.

"Fascinating implies that there is something unexpected in a phenomenon."

"Then you are not surprised something like this has happened," I concluded, playing with my rice.

"Why aren't you surprised?" Paul Casey says.

"In my opinion," says Vaccara, "You can record

Identified, cont'd...

identity, but you can't record you. So there will always be impersonators. This contour experiment has been going on in D.C. for six weeks. It was only a matter of time."

"It was supposed to be the ultimate i.d. form," Paul muses. "I guess I never really thought about it."

"The idea of personal records in a central computer has been traditionally considered flagrant, disdained."

"True," Elaine agrees, "but these are people's faces we're talking about. We don't have people being assigned numbers or something. They are being asked to use their own faces to identify themselves. Computers are supposedly verifying what we already know about ourselves. Listen, Congress was considering it for eighteen months, on and off, before the bill showed up to finance the experiment. It didn't seem like such a bad idea. You know what it's like to try to cash a check or something in a strange place. If it could have worked nationwide—"

Vaccara waves his hand to interrupt, frowning his brow, shaking his head. "Let's stop being theoretical here," he says. "We have proof here that the system can be efficiently bypassed. It will happen again, and the Census Bureau knows this."

"What they need, is a way to cover this Arlington National robbery up, and they have, essentially, instructed my superiors and me to sit on things until they contrive a practical cover up."

Elaine bristles and is about to unload on Vaccara, but Paul, who is next to her, squeezes her arm and frowns at Vaccara.

"Wait a minute," he says, squinting. "Why are you telling us about the cover up idea. That's the last thing you should do."

"I need you to keep quiet for twenty four hours," Vaccara says, leaning forward, producing another one of those lousy, green cigars from his breast pocket. There is a no smoking sign, and I think I will yank it from his mouth and stomp on it if he lights it. "I am telling you this because there isn't going to be any coverup. I need to tell a few, receptive, responsive people about it so I am assured, in case anything happens to me."

Elaine always smells funny. Her breath isn't too bad, since she brushes her teeth, but she doesn't use deodorant. Anywhere. We lie in bed, it is three a.m., and she smokes some exotic dope, which is foul.

"I don't care what Vaccara says," she rasps, the smoke taking her voice away. "I think this computer problem is fascinating."

I pull absently at her hair, exploring the mad tangles. "You don't worry too much about your appearance, do you?"

She squints, giving me a corner of the eye glance. "Now think about that," she croaks, trying to hold the smoke in. "There is a conscious decision involved in not combing my hair, right? It isn't as though I forget. In deciding that I don't feel like combing my hair, I am manifesting a concern about my appearance. Right?"

Elaine gets sophisticated as hell when she smokes; usually she is just bookish. I try never to argue with her, as I might miss something worth learning.

"You sound like you are leading up to a more ultimate point."

"I attend to my body more spartanly than you do, but I am reasonably clean and healthy."

She drops the joint in an ashtray on the floor near the bed. The phone rings, and when Elaine answers it, it

is Vaccara, so she turns the room intercom on.

"How are you, dear?" she says. "You sound as though you have just been party to a coup."

"Oh well, nothing is going to happen to me. The Census Bureau is backing off. There'll be no cover up."

"I always thought you were paranoid," Elaine comments.

"It's been an hour since we talked to you at dinner," I recount.

"I woke people up. I called the Census director at home, and simply said I was going to tell everything, that in fact I already had. Then I called my captain and got her all disoriented and mad. Then I decided to clean my cat's litter box, since I was up and she wasn't—"

"What's going to be the official story in the morning?" I say.

"The truth. Originally they had planned to say that the scanners they use to match contours with the computer were possibly toxically radiant, and shut everything down, hoping that they could improve the computer program so that a match could not be faked. I'm not into information science, but I have a hunch that that kind of insurance is not possible."

"Sounds very cloak and dagger," Elaine observes. "But could you hang up now? Jacob and I were just getting off on some foreplay."

"Oh my God—"

"Catch you later," Vaccara says.

"Yes, bring your cat over some night, and we'll have dinner together," Elaine says. They hang up.

Elaine slides down under the covers and folds her arms, holding herself.

"You think I'm so earthy and all," she suggests.

I consider it. "Yes," I decide. "Crude, even."

"The scanner terminals will be removed from everywhere by the end of the week," she says, envisioning it. "From banks and stores, from the morgue where they have to heat the bodies to get enough radiation for the scanner to get a good image, from the Welfare and unemployment agencies."

"And I love what Paul Casey said at dinner. He said, 'I never really thought about it.' Face contours are just one more scheme to keep track of people, and there are so many people to keep track of, and so many reasons that they have to be kept track of. You have to be born and fed and parented and orphaned and hired and subsidized and consulted and doctored and you have to cash checks and deposit money and buy a car and house, a stereo and television, you have to vote and run for office and get licenses to drive a car or taxi or a bus, or to fly a plane or a jet or a shuttle or get permission to leave the country or enter the country or practice law or hook or sell booze or dope or food. And you have to be identified when you're dead."

"Nobody really thinks about identification, but it can become more than an expedience. You can become too identified. Somebody borrowed your i.d. and forged another from it. You showed us how to become too identified."

"But I am a child of the sixties and seventies. Appearances, my hippie parents told me, are unimportant, it's identity that counts. It's who you are, not what you are. I don't agree. Appearance is significant. And don't tell me I never think about mine. Identity, that is the problem. I don't get off on identity, but I get off on appearance."

I role my eyes, an embarrassed child. "I never really thought about it," I smile. "Foreplay. What was that about foreplay?"

"Ah yes, foreplay," she growls, scooting close to me, so that her face is pressing against my neck. "But are you sure you don't want me to take a shower first?" ■



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Stephen B. Gray

Digital Interfacing With An Analog World, by Joseph J. Carr. Tab Books, Blue Ridge Summit, PA 17214. 406 pages, paperback \$8.95, 1978.

This book tells you how to "really put your microcomputer to work," according to the back cover, "how to convert energy produced by pressure, force, position, temperature, etc., into an electrical voltage or current that your microcomputer can deal with. It's for the user who views software as either a simple set of instructions to make the machines go or, more importantly, as a valid substitute for hardware."

The 19 chapters cover transducers, operational amplifiers, signal-processing circuits, some digital circuits, analog function modules, digital codes, data conversion, D/A and A/D converters, analog and digital multiplexing, data-acquisition systems, readout and display devices, serial data transmission, tape recorders and data loggers, and telephone-dialer circuits.

Although most of the math this handbook is full of is on the level of elementary electronics, for a full understanding of what's going on here, the reader should know or learn something about the advanced-math world of delta and sigma.

The book is full of practical circuits, and the two chapters on converters are devoted to "some real products."

Although the writing is a little stiff, there's a wealth of material here, at an easily understood level, for anybody with a head for math and a need to know how to interface the analog world to a microprocessor, computer, or other digital device.

Basic Computer Programs for the Home, by Charles D. Sternberg. Hayden Book Co., Rochelle Park, NJ. 335 pages, paperback \$3.95, 1980.

Here's a collection of 71 programs, all with easily read LISTs and RUNs, in ten categories: Home Financial (checkbook balance, income-tax recording), Automobile Related (auto maintenance, trip planning), Kitchen Helpmates (recipe conversion, supermarket list), Scheduling for Home Use (TV scheduling, reminder calendar), List Programs for Every Purpose (Christmas cards, music collections), Miscellaneous for the Home (school grade recording, weight control), Tutorial for Home Use (math practice, temperature conversion tutor), Conversion (metric, currency), Recreational (wordgame, jogger record) and Hobbyist's Diaries (golf, bowling).

Actually, the book contains 81 programs. Six are given in both basic and extended versions, and three are given in two or three versions (with and without fillers).

Although obviously the work that many of these programs do could just as easily (and in many cases, much more easily) be done with three-by-five file cards than a computer, many others should be useful, even if only now and then.

Each program is accompanied by a brief description, instructions for use, data entry, data format,

The programs should run on most small computers, except for those that don't have the MIS\$ function, used in the wordgame program.

The back cover says the book is "written by a computer expert and inventor who currently holds 24 patents." What it does not say is that Weisbecker is on the technical staff at RCA's Princeton Research Center, and designed the COSMAC VIP single-board computer.

That gives you an idea of the coverage of what is intended as "a basic reference book for all students of computer science/data processing in schools and colleges." It's quite good as a low-level dictionary, meant for non-technical readers, with easily understood definitions, such as "An ill-assorted collection of poorly matching parts, loosely fit together to form a

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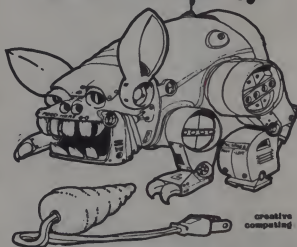
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distressing whole" for kludge. And for floppy disk "A flexible disk (diskette) of oxide-coated mylar that is stored in paper or plastic envelopes. The entire envelope is inserted in the disk unit. Floppy disks are a low-cost storage that is used widely with minicomputers and microcomputers. See magnetic disk."

Computer Dictionary. Edfac Publishing Co., 3507 Hunters Circle, San Antonio, TX 78230. 161 pages, paperback \$5.95, 1979.

The title inside the cover is "Cartoon-Style Computer Dictionary, 1979." The author is also the publisher, Don Bennet.

This hopeless book is one of those seemingly clever ideas that sound interesting in concept, but which should have been left at that. Each page illustrates with a cartoon how a non-computer person might think a data-processing word or phrase could mean, followed by the real meaning of the word or phrase, as mangled by Bennet, who knows little or nothing about computers.

A couple of examples will suffice to show that this useless dictionary is just too cute for words:

"CRT will probably not become more popular because of the high cost of coffee." The "cartoon" shows a man making a cup of "CR tea," and below is the "real" definition, "A CRT is a Carbon Ray Tube, which is a device that looks like a TV screen with a typewriter attached to it. It is used when someone wants to see some DATA, such as in making airline reservations." That's what it says, Carbon Ray Tube. With a typewriter attached.

"A COMMANDOR PET is not only the captain's pet, but..." is followed by a cartoon of a ship's captain fondling a cat, followed by "it is a MICROCOM-PUTER." Commandor? Commodore!

This dictionary is my candidate for the title of "Worst Book Ever Written About Computers."

Computer Programming for the Complete Idiot, by Donald McCunn, Design Enterprises of SF, Box 27677, San Francisco, CA 94127. 128 pages, paperback \$5.95.

This is actually a slow-and-easy manual on how to use the Radio Shack TRS-80 computer, and is meant to be used in the hands-on mode. Apparently the author believes you can just walk into a Radio Shack store and use a TRS-80 along with this book. In the introduction, McCunn says the TRS-80 was selected "because Radio Shack has many stores around the United States as well as outlets throughout the world so the TRS-80 is readily available." Then, later, "The convenience of the Radio Shack Stores makes it possible for the reader to try running a computer. The first two sections of the book... may be processed through a computer in about fifteen minutes."

The first two sections are on The Computer (operating and programming procedures, program storage) and The Computer Program.

The third section, Creating Original Programs, uses a very simple payroll program to illustrate format. The introduction says "The program should be tried out on a computer as much as the reader's circumstances allow." And as much as the store manager allows.

The book can be recommended as a reasonably good beginner's manual for the TRS-80, mainly for those who already have a TRS-80, and for those with

enough nerve to use a TRS-80 for an hour or more at a Radio Shack store.

The book is full of "type-in-and-enter" examples for hands-on use, and is written very clearly. The title is perhaps unfortunate, because anyone who buys it is tacitly admitting he's a complete idiot.

How to Computerize Your Small Business, by Jules A. Cohen, with Catherine Scott McKinney. Prentice-Hall Inc., Englewood Cliffs, NJ. 182 pages, hardcover \$13.95, paperback \$7.95. 1980.

Subtitled "Guide to selection and profitable use of computers in your firm," this guidebook was written by the head of a computer-service company that "specializes in working with clients in small businesses who are new to automation," with the help of a college teacher of business and technical writing.

The book starts with an overview of DP, looks at what a computer is (input, output, storage, CPU, programming), options available (service bureaus, time-sharing, in-house computer), selection steps, systems documentation, criteria for selection (operating requirements, response and/or turnaround time, price), the request for proposal, evaluation process, and a case study that takes up almost half the book, 83 pages.

The eight chapters get into as much detail as is possible in such a limited space, and do quite well. There is no room to get into details such as examples of time-sharing costs or more than just a page on software.

The best part of the book is the case study, which does get into great detail, with a dozen flowcharts, skeleton examples of 30 reports, ten screen menus, 19 data file descriptions, a request for proposal, and a financial evaluation and initial budget.

This is one of the best books available for the small-businessman who knows little or nothing about computers, and who wants all the basics without getting into heavy detail.

BCPL - the language and its compiler, by Martin Richards and Colin Whitby-Stevens. Cambridge University Press, New York. 181 pages, hardcover \$21.95. 1980.

According to the introduction, "The language BCPL (Basic CPL) was originally developed as a compiler-writing tool and, as its name suggests, is closely related to CPL (Combined Programming Language) which was jointly developed at Cambridge and London Universities. . . The most significant simplification is that BCPL has only one data type — the bit-pattern — and this feature alone gives it a characteristic flavor which is quite different from that of CPL and most other current programming languages. BCPL has proved itself to be useful as a compiler-writing and systems-programming tool. It has been implemented on a wide range of computers, both large and small, and has been used for research and teaching computer science as well as systems programming."

The eight chapters are on the BCPL philosophy; the main features of BCPL, advanced facilities; the library, language extensions, and machine independence; debugging and error-handling; the BCPL lexical and syntax analyzer; compiler portability; and language definition.

BCPL doesn't seem to be implemented on any computer in this country (the only hardware reference in the book is to the XDS Sigma 7), so this book is of interest mainly to hardcore software specialists. □

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Crybaby Computer Protects Newborn

When you hear a baby's cry, take note. It may be telling you something more important than "I'm hungry."

That's the idea behind a computer model developed by a Massachusetts Institute of Technology researcher who electronically analyzes the crying of newborn babies to detect hidden medical disorders.

The marriage of computer science and medicine will enable doctors to diagnose problems that often remain hidden until later in the baby's life — some times until it is too late.

Howard Golub, a Ph.D. candidate in biomedical engineering, has developed a computer program for comparing the components of a baby's cry to the cries of known normal babies.

Eventually it might be used to detect inborn metabolic errors, genetic abnormalities, low blood sugar and brain damage, Mr. Golub said.

Why can a cry tell them so much?

Crying is not a simple thing, Golub explains.

It's the result of complex muscular reactions. The acoustic signal is complex enough that a large amount of information is hidden in there.

A cry can change in frequency, intensity, resonance, timing and a number of other ways.

The investigators compared tape recordings of 55 normal, three-day-old babies to infants with known abnormalities.

They were able to identify 19 out of 21 babies suffering from jaundice and nine out of 10 with respiratory problems.

They also found a cry-analysis of babies who died of sudden infant death syndrome was markedly different from the cries of normal babies.

"The two babies that we look at that later died of SIDS seemed to have constricted vocal chords," Golub said. "None of the other babies that we looked at had those attributes."

The technique is being developed so it can be used routinely in hospital nurseries.



Casino Computers

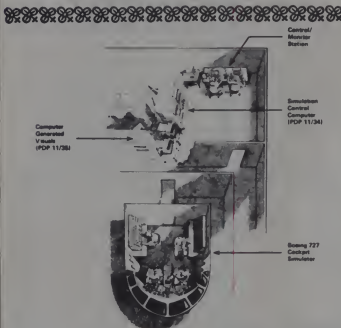
Television-like IBM computer terminals, located throughout the two Harrah's casinos in Reno and Lake Tahoe, help more than 350,000 Harrah's customers who have credit and check-cashing privileges avoid long waits for checks to clear.

The terminals are connected to twin computers that maintain the current status of each customer, after he and Harrah's agree on a credit or check-cashing limit per week. There is one terminal in each "pit," or set of blackjack, baccarat and roulette tables on the casino floor.

As a customer moves from one

set of games to another, or even from one Harrah's casino to the other, pit supervisors can enter his name into a terminal, along with a physical description if several patrons have the same name, and receive up-to-the-minute reports on his credit or check-cashing status.

Harrah's also uses the IBM computers to enter reservations for shows at the Reno and Lake Tahoe theaters, up to one month in advance. The two clubs average 21,000 reservation requests each week, with a peak of 652,000 calls in one week for a Frank Sinatra-John Denver show. It was sold out in minutes.



Aircraft Collision Avoidance Studies Use New Minicomputer System Simulations

Minicomputer Systems are being used in a series of tests to help develop collision-avoidance system equipment for jet airliners. A PDP-11/34 computer system developed by ARINC Research, linked to the PDP-11/35 computer system controlling a simulated Boeing 727 cockpit, provided warnings of "con-

licts" and night-time visual displays of as many as six aircraft in conflict situations to flight crews. Professional airline crews representing several airlines were used in a variety of tests that simulated flights between actual airports. Conflicts occurred in airport traffic patterns or en route.

Computer Circuits, Fastest Yet Made, Reported by IBM

The development of a new family of computer circuits, the fastest yet fabricated, was reported by International Business Machines Corp. researchers.

The circuits, a major advance in an experimental technology, indicate that new computers vastly more powerful than today's models may be available someday. But the circuits are yet to be proved commercially feasible and their practical application, if it ever arrives, is at least a decade off.

Called "current injection logic," the new circuits are of a type known as Josephson junctions, which operate at temperatures so cold that metals lose resistance to electric current. The lesser resistance, the faster the current flows — and the faster the computer works.

The new circuits, invented by

Tushar Gheewala, a scientist at IBM's Thomas W. Watson Research Center in Yorktown Heights, N.Y., operate in as little as 13 picoseconds, or trillionths of a second. Roughly, a picosecond is to a second what a second is to 30 years.

While today's computer circuits operate in billions of seconds, far faster computers are needed in some applications, such as weather prediction, that require enormous numbers of calculations.

Faster computers may also bring down the costs of computing, thus making it attractive in more applications and permitting the use of new types of computer programs.

IBM said the 13-picosecond time of the circuits consists of seven picoseconds for switching a circuit and six for the electrical signal to move from one circuit to the next. The speed of the signal is about the same pace that light travels through the same materials — which in theory is as fast as a signal could go.

Books For Classroom And Self Teaching

ALL GRADE LEVELS

Computers in Mathematics: A Sourcebook of Ideas

Here is a huge sourcebook of ideas for using computers in mathematics instruction. This large format book contains sections on computer literacy, problem solving techniques, art and graphing, simulations, computer assisted instruction, probability, functions, magic squares and programming styles.

One section presents over 250 problems, puzzles and programming ideas—more than is found in most "collection of problems" books.

Pragmatic, ready-to-use, classroom tested ideas are presented for everything from the most basic introduction to binary numbers to advanced techniques like multiple regression analysis and differential equations. Every item discussed has a complete explanation including flowcharts, programs and sample runs.

The book includes many activities that don't require a computer. And if you're considering expanding your computer facilities you'll find the section on how to select a computer complete with a microcomputer comparison chart invaluable.

Much of the material has appeared in *Creative Computing* but the back issues are no longer available. Hence this is your only source to this practical and valuable material. Edited by David H. Ahl, this mammoth 224-page softbound book costs only \$15.95. (The individual issues, if they were available, would cost over \$60.00). [12D]



Problems for Computer Solution

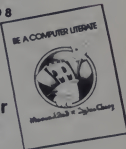
Stephen J. Rogowski

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Here are 90 problems with a thorough discussion and references for each. Eleven types of problems are included, for example, arithmetic, algebra, geometry, number theory, probability and science. Even includes three classic unsolved problems and seven appendices. 104 pages softbound, \$4.95 [9Z].

The teacher's edition contains solutions with complete listing in Basic, sample run and in-depth analysis explaining the algorithms and theory involved. 280 pp softbound, \$9.95 [9Y].

GRADES 4 TO 8



Be A Computer Literate

Marion J. Ball & Sylvia Cherp

This informative, full color book is an ideal first introduction to the world of computers. Covers kinds of computers, how they work, their applications in society, flowcharts and writing a simple program. Full color drawings, diagrams and photos on every page coupled with large type make this book easy to read and understand. Used as a text in many schools. 66 pp softbound, \$3.95 [6H].

The Impact of Computers on Society and Ethics: A Bibliography

REFERENCE

Gary M. Abshire.

Where is the computer leading us? Is it a menace or a messiah? What are its benefits? What are the risks? What is needed to manage the computer for society's greatest good? Will we become masters or slaves of the evolving computer technology? This bibliography was created to help answer questions like these. It contains 1920 alphabetical entries of books, magazine articles, news items, scholarly papers and other works dealing with the impact of computers on society and ethics. Covers 1948 through 1979. 128 pp hardbound, \$17.95. [12E].

GRADES 3 TO 8

Computer Rage

This fun and educational new board game is based on a large-scale multiprocessing computer system. The object is to move your three programs from input to output. Moves are determined by the roll of three binary dice representing bits in a computer. Hazards include priority interrupts, program bugs, decision symbols, power failures and restricted input and output channels. Notes are included for adapting game for school instruction. A perfect introductory tool to binary math and the seemingly-complex computer. [6Z] \$8.95.



The Best of Creative Computing

The first two years of *Creative Computing* magazine have been edited into two big blockbuster books. *American Vocational Journal* said of Volume 1, "This book is the 'Whole Earth Catalog' of computers." [6A] Volume 2 continues in the same tradition. "Non-technical in approach, its pages are filled with information, articles, games and activities. Fun layout." — *American Libraries*. [6B] Each volume \$8.95.

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GRADES 7 AND UP

Computer Coin Games

Computer Coin Games by Joe Weisbecker aids newcomers to the field of computers by simplifying the concepts of computer circuitry through games which can be played with a few pennies and full sized playing boards in the book. Enhanced by outrageous cartoons, teachers, students and self-learners of all ages will enjoy this 96 page softbound book. [10R] \$3.95.



Basic Computer Games

Edited by David Ahl, this book contains 101 imaginative and challenging games for one, two, or more players — Basketball, Craps, Gomoko, Blackjack, Even Wins, Super Star Trek, Bombs Away, Horserace. Simulate lunar landings. Play the stock market. Write poetry. Draw pictures.

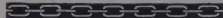
All programs are complete with listing in Microsoft Basic, sample run and description. Basic conversion table included. 125,000 copies in print. 192 pages softbound. [8C]\$7.50.



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The Best of Byte

This is a blockbuster of a book containing the majority of material from the first 12 issues of Byte magazine. The 146 pages devoted to hardware are crammed full of how-to articles on everything from TV displays to joysticks to cassette interfaces and computer kits. But hardware without software might as well be a boat anchor, so there are 125 pages of software and applications ranging from on-line debuggers to games to a complete small business accounting system. A section on theory examines the how and why behind the circuits and programs, and "opinion" looks at where this explosive new hobby is heading. 386 pp softbound. \$11.95 [6F]

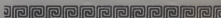
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Katie and the Computer

Fred D'ignazio and Stan Gilliam. This

is a delightful story told in words and full color drawings of Katie's adventures when she "falls" into a computer. In Katie's journey through the land of Cybernia she meets the Software Colonel, the Bytes, the Table Manager and even a ferocious Program Bug. Her journey parallels the path of a simple command through the stages of processing in a computer, thus explaining the fundamentals of computer operation to 4-10 year olds. Supplemental explanatory information is contained in the front and back end papers. 42 pp. hardbound \$6.95.



Computer Music Record

A recording was made of the First Philadelphia Music Festival which is now available on a 12" LP record. It features eight different computer music synthesizers programmed to play the music of J.S. Bach, J. Pachelbel, Rimsky-Korsakov, Scott Joplin, Nell Diamond, Lennon & McCartney and seven others. The music ranges from baroque to rock, traditional to rag and even includes an historic 1963 computerized singing demonstration by Bell Labs. \$6.00 [CR101].



Artist and Computer

This unique book by Ruth Leavitt covers the latest techniques in computer art, animation and sculpture. In its pages 35 artists explain how they use computers as a new means of self-expression. The San Francisco Review of Books said "Get yourself a copy of this book if you enjoy feeding your mind a diet of tantalizing high-impact information." Over 160 illustrations, some in full color. 121 pages hardbound [6E] \$10.00. Softbound [6D] \$4.95.



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Faulty Computing

Parkinson's Law and its various derivations have received considerable attention over the past few years. We are all amused when someone proposes a new law such as, "adding manpower to a late software project makes it later."

Since 1971, the IEEE Computer Society has been sponsoring an annual symposium on Fault-Tolerant Computing and Redundancy Techniques. Suppose the following quotations from several recent papers were presented as so-and-so's new law? We'd all laugh and go our merry way. Well, these aren't new laws; they're real. So stop and think the next time you read the next "humorous" law — it may be more real than you think.

— DHA

"The larger the computer system, the higher the probability of failure."

"Where fault-tolerant computing is most needed to enhance system reliability, it is almost completely absent."

"When a system becomes too complex and has too many interdependent parts, it eventually will collapse."

"Large computer systems have large problems in the areas of reliability, availability, and serviceability."

Puzzle Answers.

Ezra Puzzle: "I think it is a strange custom," said the man with the black tie, "and a peculiar rite, but a fact that when we enter a body, we retain a certain memory of it. The creation of laws concerning cremation is proof of its importance."

Happy Adding: The answer is 5, derived from subtracting the sum of the even numbers from that of the odd numbers.

Egg and Cannon Ball: You place the egg on the floor, in one corner of the room, in which position the walls on either side make it impossible to touch it with the cannonball.

Far A Fields: One was going to St. Ives. Remember, the traveler met these people on the road so they must have been coming from St. Ives. If they had been going to St. Ives he would have passed them, not met them on the road.

Dictionary Quiz: (1) K, (2) B, (3) M, (4) N, (5) E, (6) H, (7) I.

All Work and No Play: PLAY, CLAY, CLAP, CRAP, CROP, COOP, CORP, CORK, WORK.

A Puzzling Inscription: The letter E, which, inserted at the proper intervals, makes the inscription read as under:
PERSEVERE YE PERFECT MEN.
EVER KEEP THESE PRECEPTS TEN.

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The C8P DF utilizes full size 8" floppy disks and is compatible with Ohio Scientific's advanced small business operating system, OS-65U and two types of information management systems, OS-MDMS and OS-MS.

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