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June 1981
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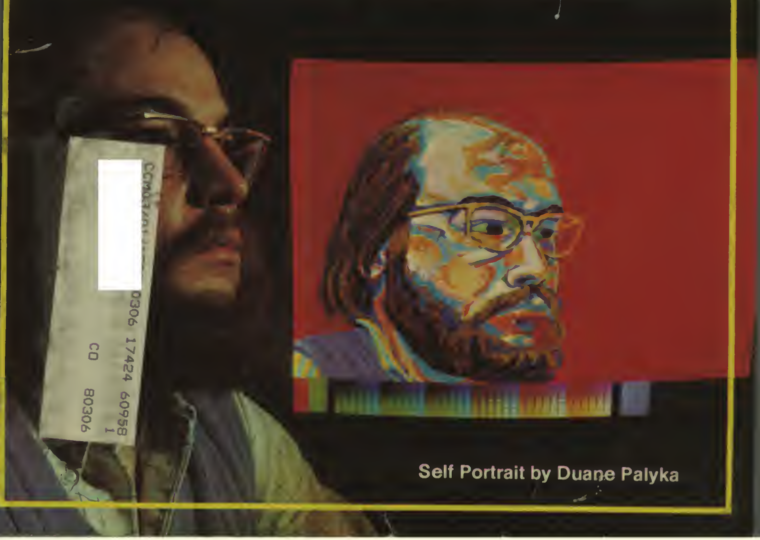

Self Portrait by Duane Palyka

IN JULY

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evaluations & profiles

articles

the cover

The cover shows artist Duane Palyka—in the flesh and as his computer paints him. Some of Mr. Palyka's ideas on computer art are found in the story on page 46.

applications & software

fiction & foolishness

departments

JUNE, 1981 **VOLUME 7, NUMBER 6**

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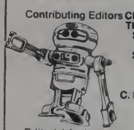

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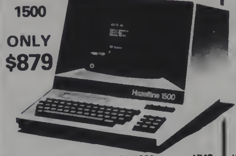

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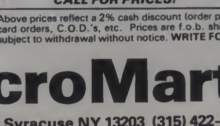

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More on VideoBrain

In my follow-up on Bally and Interact, I indicated that I had no further information on VideoBrain. Finally a few items have surfaced. Umtech, the original manufacturer of the VideoBrain, stated that all current sales are curently being handled by C.O.M.B. Company, Inc., 3258 Minnehaha Avenue, Minneapolis, MN 55406. Telephone (800) 328-5082. Some joysticks and other parts may also be found at a "salvage" dealer, Quinntronics, Langley St., Oakland, CA. Telephone (415) 569-1529.

One of VideoBrain's niftiest pieces of software, APL, was never put into production and only about 50 prototypes were ever made. Too bad—DHA

NECC

The National Educational Computing Conference '81 will be held June 17-19, 1981 at North Texas State University in Denton, Texas. Contact Dr. James L. Poirot, North Texas State University, P.O. Box 13886, Denton, TX 76203, (817) 788-2767 for registration details.

Harvard Computer Graphics Week '81

The International Users' Conference on Computer Mapping and Management Graphics (July 26-31, 1981) will be directed toward current and potential users and will offer new developments, examples of computer mapping and management graphics applications, and numerous opportunities for interaction among speakers, exhibitors, and audience members. Topics will be covered through lectures, workshops, panels, roundtable discussions, poster exhibits, mini-seminars, and displays.

For more information, write: Harvard Computer Graphics Week, Harvard Laboratory For Computer Graphics, 520 Gund Hall, 48 Quincy St., Cambridge, MA 02138.

Do You Have Two Computers?

If you have access to two computers, are looking for a challenge and could use some extra spending money, we may have just the thing. Creative Computing Software is continually releasing new software packages for one brand of computer that we would like to make available for other computers too. It's easy to convert parts of the code, but the graphics are usually more difficult. Hence, the conversion can seldom be done from just a listing—it's necessary to have both machines.

If you have access to two or more of any of the following computers, we'd like to hear from you. They are: TRS-80, Apple, Atari, PET, TI, Sorcerer and CP/M. Please write describing your computer configurations, programming expertise and time available to John White, Creative Computing Software, 39 E. Hanover Ave., Morris Plains, NJ 07960.

Cursor Confusion

In the Bally follow-up, we noted a magazine named *Cursor* for Bally owners. We trust readers did not confuse this with the much larger and older *Cursor* magazine published for PET owners by Ron Jeffries of The Code Works, Box 550, Goleta, CA 93116.

More on MECC

I goofed. Because of pressing deadlines, the transcripts of the interviews with MECC staff members were not reviewed by MECC. Two specific errors should be corrected. On page 122, the person by the CDC computer is Mark Rustad, not Rick Nordin as listed. On page 132, the statement about Apples in for repair referred to half of the 25 MECC-owned Apples, not half the Apples in Minnesota. Furthermore, I was there on what just happened to be the worst maintenance situation MECC ever had. More typically, one of MECC's 25 Apples would be in for maintenance.—DHA

Help Solve a Murder!

On Sunday, the 22nd of February, the A.B.S. Computer Services Store in Olympia, Washington was robbed, and the owners, Henry and Laverne Rumberger, were killed. The following equipment was taken:

Apple III, 128K	Serial Number 001065
Apple II	11892
Apple II	152415
Apple II	95802
Disk II, with controller	215227
BMC Monitor	65101709
Sony KB1216 TV	503527
Centronics 737 Printer	12349
IDS 440 Paper Tiger Printer	3166

If you discover any of these items, please contact the Olympia Police Department at (206) 753-8300.

To Authors

Creative Computing is seeking articles, applications, reviews and software for publication in the magazine and through the software division. Prospective authors should send a self-addressed stamped envelope (SASE) for a copy of our Author's Guide.

All submissions must also be accompanied by a SASE if material is to be returned. Manuscripts must be typed, double space. We typeset directly from Scripsit, Wordstar and Electric Pencil disks so please include disk if available.

Send submissions to: Creative Computing Editorial/Software Department, 39 E. Hanover Ave., Morris Plains, NJ 07960.

Correction

On page 53 of our March issue we listed a price of $399 for APF's Imagination Machine II. The Imagination Machine II is a complete system that is sold as a package with floppy interface, expansion box, serial interface and floppy disk and retails for $1199. The computer is not sold separately.

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WOULD YOU LIKE TO EXPRESS YOURSELF IN A PERSONAL VISIT TO AN EDITOR?

See More Logo

Dear Editor:

I enjoyed the excerpt from *Mindstorms* (March 1981 *Creative Computing*). It's the best article on computers in education that I've seen lately. It stimulates thought on areas of computer use in classrooms that many of us have not thought of before (e.g. word processing).

As for Logo, I'd like to see articles written by educators *and students* who have used the software. Possibly a student with experience using both Basic and Logo programs could offer valuable insights into the benefits and problems associated with the ease of use and teaching capabilities of each.

The article on "Computers and Hyperactive Children" also interested me. I wonder, however, was the computer responsible for the increased attention span, or were the students' aversions to their human instructor's attitude and methods the reason? The data were impressive, but *all* factors must be considered before conclusions can be valid.

Paul J. Goedicke
404 N. 9th
Keokuk, IA 52632

Fan Letter

Dear Editor:

I'd like to address Ken Brumbaugh's statement that "more than one-half of the Apples that MECC has purchased are in for repair" (page 132 of March 1981 issue). The Apple II computer, great as it is, suffers from the serious shortcoming of inadequate internal cooling. Most of the electronic circuits lie on one large, flat "motherboard." There is no provision for moving the warm air generated by these circuits. The slots on the sides and bottom cannot force air movement across the circuit board.

Fortunately, there is a convenient, low-cost answer: push the warm air with a small fan. When I purchased my Apple fifteen months ago, it didn't take me very long (as an electronics engineer) to see that the computer was getting too warm for reliable performance, and why. I have since used two types of instrument fans, each with excellent results.

The first fan I used was an IMC Boxer fan model WS2107FL-9. This is the "whisper" version of a small (4.7" square) but noisy fan widely used to cool electronic instruments, such as computers. I placed this fan at the rear of the Apple, flush, blowing air in through the cable slots. To prevent air from being blown under the computer and chilling the user's hands, I set the fan on a 3/4" thick paperback book. I plugged the fan into the system plugstrip, so it would come on with the Apple. The low noise produced by this quiet fan is compatible with home, school and office computing environments.

The second fan is more compact, the Torin TA300S. This fan is sufficiently small (3 1/4" square) and narrow (1 1/2") to mount inside the Apple chassis, on the right side, in front of where the TV modulator is normally placed. A piece of double-sided sticky tape holds it on the bottom, against the edge of the Apple printed circuit board, and a small piece of foam on top wedges it securely in place. The fan draws air in through the side slots and blows it across the memory chips. The air exits across the top of the power supply and out the adjacent vents. "Smoke tests" using a transparent top demonstrated this air flow quite dramatically.

Internal fan cooling can be made more effective with some simple ducting, but this is only necessary for a system with lots of accessory cards. With the quiet Torin fan in place, the user can hardly tell his Apple is turned on. Except, of course, that it runs much cooler and doesn't break down.

One caveat: on very cold days, it may be necessary to unplug the fan until the room warms up. Some Apples, my own included at times, balk at temperatures lower than those reasonably comfortable for people. In most institutional environments, the machine runs all day, and this would not be a problem. This is a minor inconvenience for the greatly extended life that can be obtained in so inexpensive and convenient a manner.

Elevated temperature operation is the only enemy (aside from Coke and coffee) the Apple encounters in normal operation. The Apple II computer should work for a long time without trouble. Properly cared for, it will.

Harry E. Brawley, Jr.
18 Tufts Street
Cambridge, MA 02139

See Notices, page 6.—Ed.

put...input/output...in

Gone Public

Dear Editor:

Your March 1981 issue on Education was outstanding. The article by Seymour Papert was exceptional as were the articles on the Minnesota Educational Computing Consortium and the article "Van Helps Schools Select Computer."

The listing of educational sources by Dr. Lopez was greatly needed, but I would like to correct one small error. Educational Software, listed as a software source, is no longer an operating company. In the summer of 1980 all of their assets, including their software copyrights, were donated to the Center for Educational Research.

At this time the Center does not have the resources or desire to market software programs directly. However, the Center staff is available on a limited basis for consulting and contract software development. Readers interested in using computers in elementary special education may contact Dr. Richard Swenson, or James C. Kingman, at 801 East Sixth Avenue, Helena, MT 59601. The Center's phone number is (406) 443-3600.

James C. Kingman
President
Center For Education Research
801 East Sixth Avenue
Helena, MT 59601

Sort Story

Dear Editor:

This is a reply to the letters you published in the March issue, by Grady Early and David M. Chess, which criticized my article "Extremely Fast Sorting" (November 1980).

"I know of no reputable author," Mr. Early writes, "who claims that $n \log n$ is an absolute lower bound on the number of steps required to place any set of records into some predefined order." The people in industry who are designing sorting systems are not, most of them, authors at all. And many of the managers who must approve such systems know only that there are people who are claiming that you can't sort n records any faster than $n \log n$. As a result, if the managers are buying sorting systems, they accept $n \log n$ without any thought of possible improvements.

Secondly, Mr. Chess, I hope that my remarks, above, to Mr. Early will explain why I seem hostile to you. I think that indignation is a better word than hostility, though. Waste does make me indignant, although it is excusable when it arises from ignorance. It is not excusable, however, when it arises from the fact that managers are ignorant of the technical details of papers in computer science (as indeed they will always be; otherwise they would be computer scientists, not managers).

Both Mr. Early and Mr. Chess make valid points which reinforce and strengthen my principal thesis. *Of course* it is possible to do even better than the scheme I outlined; it almost always is possible to improve on any published algorithmic procedure.

W.D. Maurer
George Washington University
School of Engineering
and Applied Science
Washington, D.C. 20052

Wails From the Crypt

Dear Editor:

On page 60 of your December 1980 issue, an article by Frank Covitz entitled "The PET," says "...the STOP key can be deactivated under program control..."

Well, we here at Hunter knew it *could* from our seeing it in many commercial programs.

But HOW?

The Computer Room
Hunter High School
c/o Nic Wolff
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Try POKE 537, 136 (old PET); POKE 144, 136 (new PET). —DL

Calling Art Linkletter

Dear Mr. Ahl
I have sent you my article. If you want to use it in your Magazine, write me.

Thanks

I am 9 years old

The Apple Two Plua ia a good personal computer because it can do so many different things. For instance it can teach a child his multaplacation tablea from 1 to 10 in a matter of daya depending how long the child apends with the computer. The Apple can also entertain. For instance the apple lets you play games like space invaders, Chess, Checkers, Football, Hockey ,and adventure games like Dungeonw and Dragons. These disks run from about 15$ to 55$ depending on the game.

The Apple 2,s key board looks like a normal typewriter with a few ad on's such as the return key and the esc key.

The computer language the Apple two understands ia so easy that a child at the age of 10 could understand it. There are a few books you can buy that tells about computer programing such as Cumputers for kids, More computer games, and Katie and the cumputer. These books are sold at moat computer storea.

David C. Dunn, Jr.
3331 Wycliffe Drive
Modesto, CA 95355

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CARD GAMES

BRIDGE 2.0 (Available for all computers) **Price: $17.95 Cassette/$21.95 Diskette**
An all-inclusive version of this most popular of card games. This program both BIDS and PLAYS either contract or duplicate bridge. Depending on the contract, your computer opponents will either play the offense OR defense. If you bid too high, the computer will double your contract! BRIDGE 2.0 provides challenging entertainment for advanced players and is an excellent learning tool for the bridge novice. See the software review in 80 Software Critique.

HEARTS 1.5 (Available for all computers) **Price: $15.95 Cassette/$19.95 Diskette**
An exciting and entertaining computer version of this popular card game. Hearts is a trick-oriented game in which the purpose is not to take any hearts or the queen of spades. Play against two computer opponents who are armed with hard-to-beat playing strategies. HEARTS 1.5 is an ideal game for introducing the uninitiated (your spouse) to computers. See the software review in 80 Software Critique.

STUD POKER (Atari only) **Price: $11.95 Cassette/$15.95 Diskette**
This is the classic gambler's card game. The computer deals the cards one at a time and you (and the computer) bet on what you see. The computer does not cheat and *usually* bets the odds. However, it sometimes bluffs! Also included is a five card draw poker betting practice program. This package will run on a 16K ATARI. Color, graphics, sound.

POKER PARTY (Available for all computers) **Price: $17.95 Cassette/$21.95 Diskette**
POKER PARTY is a draw poker simulation based on the book, POKER, by Oswald Jacoby. This is the most comprehensive version available for microcomputers. The party consists of yourself and six other (computer) players. Each of these players (you will get to know them) has a different personality in the form of a varying propensity to bluff or fold under pressure. Practice with POKER PARTY before going to that expensive game tonight! Apple Cassette and diskette versions require a 32 K (or larger) Apple II.

CRIBBAGE 2.0 (TRS-80 only) **Price: $14.95 Cassette/$18.95 Diskette**
This is simply the best cribbage game available. It is an excellent program for the cribbage player in search of a worthy opponent as well as for the novice wishing to improve his game. The graphics are superb and assembly language routines provide rapid execution. See the software review in 80 Software Critique.

THOUGHT PROVOKERS

FLIGHT SIMULATOR (Available for all computers) **Price: $17.95 Cassette/$21.95 Diskette**
A realistic and extensive mathematical simulation of take-off, flight and landing. The program utilizes aerodynamic equations and the characteristics of a real airfoil. You can practice instrument approaches and navigation using radials and compass headings. The more advanced flyer can also perform loops, half-rolls and similar aerobatic maneuvers. Although this program does not employ graphics, it is exciting and very addictive. See the software review in COMPUTRONICS.

VALDEZ (Available for all computers) **Price: $15.95 Cassette/$19.95 Diskette**
VALDEZ is a computer simulation of supertanker navigation in the Prince William Sound/Valdez Narrows region of Alaska. Included in this simulation is a realistic and extensive 256 × 256 element map, portions of which may be viewed using the ship's alphanumeric radar display. The motion of the ship itself is accurately modelled mathematically. The simulation also contains a model for the tidal patterns in the region, as well as other traffic (outgoing tankers and drifting icebergs). Chart your course from the Gulf of Alaska to Valdez Harbor! See the software review in 80 Software Critique.

BACKGAMMON 2.0 (North Star only) **Price: $18.95**
This full version of the classic board game uses clever tactics to insure a challenging game. The board printout assumes the use of a 16 × 64 video display. You will find BACKGAMMON 2.0 to be an excellent learning device as well as a tough opponent.

NOMINOES JIGSAW (Atari, Apple and TRS-80 only) **Price: $16.95 Cassette/$20.95 Diskette**
A jigsaw puzzle on your computer! Complete the puzzle by selecting your pieces from a table consisting of 60 different shapes. NOMINOES JIGSAW is a virtuoso programming effort. The graphics are superlative and the puzzle will challenge you with its three levels of difficulty. Scoring is based upon the number of guesses taken and by the difficulty of the board set-up.

CHESS MASTER (North Star and TRS-80 only) **Price: $19.95 Cassette/$23.95 Diskette**
This complete and very powerful program provides five levels of play. It includes castling, en passant captures and the promotion of pawns. Additionally, the board may be preset before the start of play, permitting the examination of "book" plays. To maximize execution speed, the program is written in assembly language (by SOFTWARE SPECIALISTS of California). Full graphics are employed in the TRS-80 version, and two widths of alphanumeric display are provided to accommodate North Star users.

MONARCH (Atari only) **Price: $11.95 Cassette/$15.95 Diskette**
MONARCH is a fascinating economic simulation requiring you to survive an 8-year term as your nation's leader. You determine the amount of acreage devoted to industrial and agricultural use, how much food to distribute to the populace and how much should be spent on pollution control. You will find that all decisions involve a compromise and that it is not easy to make everyone happy.

CHOMP-OTHELLO (Atari only) **Price: $11.95 Cassette/$15.95 Diskette**
CHOMP-OTHELLO? It's really two challenging games in one. CHOMP is similar in concept to NIM, you must bite off part of a cookie, but avoid taking the poisoned portion. OTHELLO is the popular board game set to fully utilize the Atari's graphics capability. It is also very hard to beat! This package will run on a 16K system.

**ATARI, PET, TRS-80, NORTHSTAR, CP/M and IBM are registered tradenames and/or trademarks*

***TRS-80 diskettes are not supplied with DOS or BASIC*

AND MORE...

STARTREK 3.2 (Available for all computers) **Price: $11.95 Cassette/$15.95 Diskette**
This is the classic Startrek simulation, but with several new features. For example, the Klingons now shoot at the Enterprise without warning while also attacking starbases in other quadrants. The Klingons also attack with both light and heavy cruisers and move when shot at! The situation is hectic when the Enterprise is beseiged by three heavy cruisers and a starbase S.O.S. is received! The Klingons get even! See the software reviews in A.N.A.L.O.G., 80 Software Critique and Game Merchandising

BLACK HOLE (Apple only) **Price: $14.95 Cassette/$18.95 Diskette**
This is an exciting graphical simulation of the problems involved in closely observing a black hole with a space probe. The object is to enter and maintain, for a prescribed time, an orbit close to a small black hole. This is to be achieved without coming to near the anomaly that the tidal stress destroys the probe. Control of the craft is realistically simulated using side jets for rotation and main thrusters for acceleration. This program employs Hi-Res graphics and is educational as well as challenging.

SPACE TILT (Apple only) **Price: $10.95 Cassette/$14.95 Diskette**
Use the game paddles to tilt the plane of the TV screen to "roll" a ball into a hole in the screen. Sound simple? Not when the hole gets smaller and smaller! A built-in timer allows you to measure your skill against others in this habit-forming action game.

MOVING MAZE (Apple only) **Price: $10.95 Cassette/$14.95 Diskette**
MOVING MAZE employs the games paddles to direct a puck from one side of a maze to the other. However, the maze is dynamically (and randomly) built and is continually being modified. The objective is to cross the maze without touching (or being hit by) a wall. Scoring is by an elapsed time indicator, and three levels of play are provided

ALPHA FIGHTER (Atari only) **Price: $14.95 Cassette/$18.95 Diskette**
Two excellent graphics and action programs in one! ALPHA FIGHTER requires you to destroy the alien starships passing through your sector of the galaxy. ALPHA BASE is in the path of an alien UFO invasion; let five UFO's get by and the game ends. Both games require the joystick and get progressively more difficult the higher you score!

INTRUDER ALERT (Atari only) **Price: $16.95 Cassette/$20.95 Diskette**
This is a fast paced graphics game which places you in the middle of the "Dreadstar" having just stolen its plans. The droids have been alerted and are directed to destroy you at all costs. You must find and enter your ship to escape with the plans. Five levels of difficulty are provided. INTRUDER ALERT requires a joystick and will run on 16K systems.

GIANT SLALOM (Atari only) **Price: $14.95 Cassette/$18.95 Diskette**
This real-time action game is guaranteed addictive! Use the joystick to control your path through slalom courses consisting of both open and closed gates. Choose from different levels of difficulty, race against other players or simply take practice runs against the clock. GIANT SLALOM will run on 16K systems.

GAMES PACK I (Available for all computers) **Price: $10.95 Cassette/$14.95 Diskette**
GAMES PACK I contains the classic computer games of BLACKJACK, LUNAR LANDER, CRAPS, HORSERACE, SWITCH and more. These games have been combined into one large program for ease in loading. They are individually accessed by a convenient menu. This collection is worth the price just for the DYNACOMP version of BLACKJACK.

GAMES PACK II (Available for all computers) **Price: $10.95 Cassette/$14.95 Diskette**
GAMES PACK II includes the games CRAZY EIGHTS, JOTTO, ACEY-DUCEY, LIFE, WUMPUS and others. As with GAMES PACK I, all the games are loaded as one program and are called from a menu. You will particularly enjoy DYNACOMP's version of CRAZY EIGHTS.

Why pay $7.95 or more per program when you can buy a DYNACOMP collection for just $10.95?

MOON PROBE (Atari only) **Price: $11.95 Cassette/$15.95 Diskette**
This is an extremely challenging "lunar lander" program. The user must drop from orbit to land at a predetermined target on the moon's surface. You control the thrust and orientation of your craft plus direct the rate of descent and approach angle.

ADVENTURE

CRANSTON MANOR ADVENTURE (North Star only) **Price: $21.95**
At last! A comprehensive Adventure game for North Star. CRANSTON MANOR ADVENTURE takes you into mysterious CRANSTON MANOR where you attempt to gather fabulous treasures. Lurking in the manor are wild animals and robots who will not give up the treasures without a fight. The number of rooms is greater and the associated descriptions are much more elaborate than the current popular series of Adventure programs, making this game the top in its class. Play can be stopped at any time and the status stored on diskette.

ABOUT DYNACOMP

DYNACOMP is a leading distributor of small system software with sales spanning the world (currently in excess of 40 countries). During the past two years we have greatly enlarged the DYNACOMP product line, but have maintained and improved our high level of quality and customer support. The achievement in quality is apparent from our many repeat customers and the software reviews in such publications as COMPUTRONICS, 80 Software Critique and A.N.A.L.O.G. Our customer support is as close as your phone. It is always friendly. The staff is highly trained and always willing to discuss products or give advice.

On Little Feet

Dear Editor:

The Reading Level Program in the March, 1981 *Creative Computing* contains an error in line 710. Actually the error has been carried over from the original program published in April, 1980. The basic formula which computes grade level of text material is the FOG index. Line 710 as published reads:

R=.4*(T+W/S)

where T=number of three-syllable (or more) words
W=number of words in the passage
S=number of sentences in passage

This formula places entirely too much weight on the three syllable words (T). In fact, the grade level would rise automatically as the length of the passage increased. What is needed is the *percentage* of three-syllable words rather than a raw score. This can be obtained by changing line 710 to read:

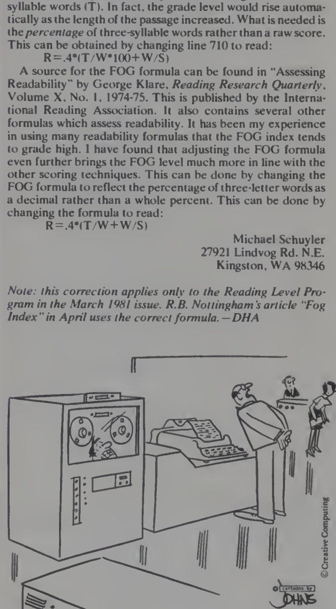
R=.4*(T/W*100+W/S)

A source for the FOG formula can be found in "Assessing Readability" by George Klare, *Reading Research Quarterly*, Volume X, No. 1, 1974-75. This is published by the International Reading Association. It also contains several other formulas which assess readability. It has been my experience in using many readability formulas that the FOG index tends to grade high. I have found that adjusting the FOG formula even further brings the FOG level much more in line with the other scoring techniques. This can be done by changing the FOG formula to reflect the percentage of three-letter words as a decimal rather than a whole percent. This can be done by changing the formula to read:

R=.4*(T/W+W/S)

Michael Schuyler
27921 Lindvog Rd. N.E.
Kingston, WA 98346

Note: this correction applies only to the Reading Level Program in the March 1981 issue. R.B. Nottingham's article "Fog Index" in April uses the correct formula.—DHA



"Who's the clown who wrote 'I'm being held in this computer against my will!'?"

The Inexpensive Spread

Dear Editor:

While not expressly documented in the EasyWriter manual, it is possible to print double wide characters by simply using the user-defined keystroke capability. On my IDS-440 I simply define a character as ASCII 01 to enable double wide characters and then redefine it as ASCII 02 to return to standard width characters.

EXAMPLE:

```
.U
.U#01
#Sample of double wide characters
.U
.U#02
#Back to standard sized characters
```

You have to watch the number of characters you print per line as the program doesn't maintain a correct line width using this method but it works fine for printing short titles and headings.

Michael A. Mahoney
Singapore

Finishing Touches

Dear Editor:

I enjoyed David Miller's Apple-Sketch program (*Creative Computing*, January 1981) very much. My kids have spent many enjoyable hours with it.

In the process of working with Apple-Sketch, I have made the program easier and more flexible to use with two simple modifications. Your readers might like to try them.

There is a slight difficulty when drawing pictures with the small pen size in that a smooth line is not plotted if you turn the game paddles too fast. Mr. Miller refers to this problem in his article and it is because the execution speed of Applesoft cannot keep up with the paddles. This can be corrected by the following replacement for line 200:

```
200 HPLOT X,Y: HPLOT TO X,Y: GOTO 110
```

This change plots all the points between two readings of the game paddles and results in smooth lines being drawn.

The second modification involves making it possible to print the product of your efforts on a Silentype printer directly from Apple-Sketch. With this change, all you do to print the sketching screen is type CNTL-Q at any time the program can accept a command. Add the following line to accomplish this:

```
302 IF A$=CHR$(17) THEN PR#1: PRINT A$: RETURN
```

This change simply turns on the Silentype and sends the CNTL-Q to it to print the screen. It assumes the Silentype interface card is plugged into slot #1. The PR#1 can be changed to any slot the card is plugged into. The following replacement and addition lines add the CNTL-Q to the commands page display:

```
1000 TEXT: HOME: HTAB 6:PRINT "***LIST OF COMMANDS ***": PRINT
```

The above makes room for another line on the page.

```
1175 INVERSE: PRINT "CTRL";: NORMAL: PRINT "Q - PRINT THIS PICTURE"
```

The above actually adds the line to the list of commands.

Richard I. Marmon
1118 Michelle Pkwy.
Papillion, NE 68046

Dragon Fire™

Is untold wealth worth the risk?

Dragon Fire is a trademark of Level-10. Apple is a trademark of Apple Computer Inc.

Salmadon is no ordinary creature. Fables describe him as a nightmare made flesh. His dungeon is ten (10) levels deep and filled with hideous creatures.

They dwell within the maze of caverns for only one reason: to keep you from reaching the Great Dragon and his wealth. There is no map. The levels and rooms seem to rearrange themselves at will.

As you battle your way deeper into the dungeons you find keys to the Great Dragon's lair. But which one is the magic key?

Remember you cannot take the wealth from Salmadon's lair without slaying him, and you cannot slay the great dragon without one of the right keys.

Dragon Fire is an intricate strategy adventure with 170 monsters guarding over 150 different treasures.

The random generation of the rooms and mazes makes each game unique. It can be played on a color or black and white monitor. It includes sound, hi-res graphics and a "save the adventure" feature.

Dragon Fire is written in Integer Basic for the Apple II and Apple II Plus with 1 disk drive and 48K RAM. Contact your local computer store, hobby store or contact Level-10, a subsidiary of Dakin5 Corporation, Post Office Box 21187 Denver, Colorado 80221

LEVEL-10™

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CIRCLE 122 ON READER SERVICE CARD

Frost Your Microcomputer Cake with High-Resolution Graphics

David Holtz

If you've longed for the graphics capability of Apple, Sorcerer, or Pet microcomputers, then it's time to put high resolution graphics frosting on your TRS-80 Microcomputer cake.

The 80-Grafix board from Programma International (2908 N. Naomi St., Burbank, CA 91504) puts 384 x 192 resolution at your fingertips. You can easily program up to 64 characters while your creative imagination races merrily along. In a 6 x 12 matrix format, you can create whatever characters or symbols you need for your special programming, hobby or business applications. If you need larger symbols, you simply concatenate the characters—or you POKE or PRINT the symbols individually as a concatenated variable, or with conventional program loops.

Maybe you have a use for Greek, French, or Arabic characters. Or playing card or game symbols, space ships and other unique characters would add an exciting new dimension to your programs. Perhaps you have special graphic needs for your business profession. If any of these spark your interest, then you don't have to look any further. You can even have inverse video or lower case!

And there is software from Programma that will patch the 80-Grafix board-generated lower case directly to Radio Shack's Scripsit word processor. If you've taken a look at the price of hardware-generated lower case with descenders and have planned to take the step, then for a modest additional investment in the Grafix-board, you can link your software-created lower case character set to the Scripsit package and realize high-resolution graphics capabilites besides.

All of this high-resolution capability is wrapped up in a 2 1/4" x 5 1/4", double-sided circuit board that fits snugly in a recessed "well" in the bottom of the TRS-80 case. It requires only two solder connections plus mounting of male DIP connectors over the top of four ICs. You can either push on the DIP connectors or solder the connections to the ICs.

The Package

I'm impressed by the comprehensive 30-page manual that leaves little to your imagination as you methodically step through the installation. There's even a trouble-shooting section if you need it (and you shouldn't if you followed instructions carefully, for the board has been "burned-in" and tested at the factory). An illustration and a labeled sketch show where the board and cables go.

You get a good look at the theory of operation, and then learn how to use the board's capabilities. Seven pages of how-to-use-it instructions are supplemented by application programs and a lower case character set on an accompanying cassette tape. It is helpful to study the program listings in the manual and from the tape to add to your application ideas.

Available Modes

There are three different operating modes, all controlled by the OUT 255 command in your Basic program, but the TRS-80 automatically powers up in conventional graphics mode. OUT 255,32 provides standard TRS-80 characters and graphics. OUT 255,160 puts you into hi-resolution mode, and lets you use the special characters you've programmed into the 80-Grafix board. Standard alphanumeric characters are not affected, but cannot intermix conventional TRS-80 graphics characters and hi-res characters unless you've programmed the standard configuration into your hi-res set. OUT 255,96 is the programming mode for setting up and storing character patterns into Programmable Character RAM (PCR). This mode is used only when programming new character information into the board.

Mode and character programming control, of course, are available using assembly language, too, and Programma has thoughtfully included a section on assembly language techniques. The section includes a complete source listing for a keyboard driver which displays unshifted and shifted (upper and lower case, respectively) characters or whatever character set you happen to have programmed into the 80-Grafix board. The cassette has a SYSTEM program and a disk version which provide a lower case character set with video drivers.

How It Works

Instead of the 5 x 7 dot character matrix that exists in the standard TRS-80 character generator ROM, the 80-Grafix board expands the graphics cells to a 6 x 12 matrix (or resolution of 384 horizontal by 192 vertical). The board, incidentally, has its own 1K (byte) by 6 (bit) memory so you don't have to sacrifice any RAM to obtain hi-res graphics.

David D. Holtz, 91 Valley St., Rochester, NY 14612.

Imagine adding the excitement of high resolution 382 x 192 graphics to your programs. Note the fine detail possible in the spaceship design.

Unique symbols and characters can be quickly created and used via several alternate programming methods you can choose. Or you can use standard TRS-80 graphics with a simple OUT command in Basic.

This 1K by 6 memory block of PCR is organized into 64 fields, each consisting of individual character data when information has been programmed into it. Four of the 16 bits in each field are ignored, so in effect you are using the first 12 bytes for the 12 data lines of each character.

The video memory (a separate 1K block of RAM) acts as a buffer when you enter the programming mode. According to the manual, the hi-res character data is moved to the screen, then read as the image of the PCR, and stored into PCR memory. Once data for all hi-res characters is stored, one exits to high resolution mode (OUT 255,160). All of this, of course, is under software control, so it is being done automatically for you.

Characters are transferred to the screen using PRINT, PRINT @, or POKE statements (or with a video driver via the keyboard).

Although you can't access every single dot on the screen using cursor control for free-form driving, for example, you can access any dot on the video screen depending upon how each of the 6 x 12 elements of the 64 hi-res characters is programmed. So you can do full screen plotting, but access to each dot on the screen is not supported, according to Programma.

Programming Characters

You can program characters into the PCR in several ways. A very simple but somewhat time-consuming way involves designing a character with the aid of a handy 6 x 12 grid form in the back of the manual. A photo-copying machine provides an economical worksheet supply for further programming needs.

First you darken the spaces in the 6 x 12 grid to correspond to the image you wish to create. Then, think of the 6 horizonal blocks in each grid line in terms of binary numbers. That is, a lighted block would be a one; an unlighted block, a zero. With a little practice, one becomes very facile adding the six digit binary numbers, and standard patterns, of course, produce the same sum as you move from character to character. You add each of the 12 lines in the grid block of the character, then simply insert the 12 decimal figures into a DATA line in your Basic program.

The 80-Grafix board expands the graphics cells to a 6 x 12 matrix.

As mentioned before, you set the board to hi-resolution via OUT 255,160 in your Basic program. Then a simple FOR-NEXT loop programs the board using READ and POKE statements.

Clear instructions and program syntax are included in the manual and illustrative programs you receive. After data is read, board programming accomplished, and the computer switched to high resolution mode, you are ready to use the special characters in your program.

If your computer is disk-based, character data lines can be saved for handy reference and merged at any future time to incorporate the same character data into other programs. Otherwise, the character DATA figures will have to be typed into new programs.

An easier way is to use the Basic language "Create" program, supplied on the accompanying cassette and documented/listed in the manual. By inputting X-Y coordinates for the 6 x 12 cells, the program prints out a decimal figure to enter into your DATA line—much easier. Each of the cell coordinates has to be entered individually, but it is a marked speed improvement over the manual grid sheet method.

The best way, and I recommend it to anyone who purchases the 80-Grafix board, is to order from Programma International their HIRES80 high resolution graphics editor, a fast machine language program that adds great versatility to your character programming. Its strongest feature is the speed it contributes to your character design. In addition to pre-programmed characters sets (among them an upper/lower case set, inverse character set, fractions, Arabic and Hebrew sets), there is a separate utility program that provides a special video driver for your keyboard. Inverse characters can be obtained by simply pressing a key as you create your character. In my opinion, the HIRES80 graphics editor is the best way to go.

Installing the Board—Decision Points

There are three decisions you will have to make before proceeding. If your warranty is still in effect, you'll have to bite the bullet—decide to break the computer warranty seal and install now, or wait until the warranty ends. In my case, I installed 16K memory chips from Ithaca Audio the same day I bought my computer, so I proceeded full speed ahead.

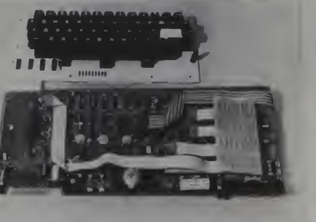
Another decision is whether to install the board yourself or have a qualified electronics technician do it for you. If you are not familiar with digital electronics, then your answer is pretty clear cut. You should probably seek assistance.

Another choice is the method of installing the four male DIP pin ribbon connectors on top of appropriate ICs. Programma's manual recommends that connectors be pressed directly onto the top of the ICs, and suggests a drop of glue (or double-faced tape) on top of the ICs for proper adhesion of connectors. The manual says that tests have shown connections such as these to be reliable.

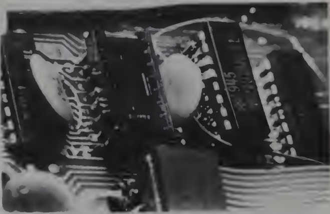
But Programma gives you an alternative. You can mount low profile IC sockets over the top of the ICs and securely solder the socket and IC pins together. It's a bit tricky soldering in tight quarters, but there is real assurance your connection will stay in place if you tote your computer around.

Since the manual is so complete, I'll simply cover special points I observed along the installation route.

The most tedious and painstaking part I encountered was making sure I had good solder connections between the pins of the ICs and the pins of the low-profile sockets mounted above. Quarters are fre-



Four "push-on" male DIP connectors mount on top of existing ICs. Two solder connections are necessary, plus one IC lead to be clipped.



One can solder low-profile IC sockets onto the pins of the four ICs that will receive the DIP-pin ribbon connectors. Special care is necessary when soldering. The Radio Shack lower-case modification (see piggy-backed ICs) is next to one of the ribbon connector points.

quently close, so you need a good light, a low-wattage soldering iron, a steady hand, and a bit of time.

I found a magnifying glass handy to check out the solder connections and make sure I didn't have any solder bridges. A handy way to check for bridges between the fine traces interconnecting the computer ICs is to position a good light source (a high intensity light, for example) below the PC board. You should be able to see any bridging outlines from the opposite side of the board.

One snare I ran into was my Radio Shack lower case modification. In my unit, a 2102AN-4L chip is piggy-backed over IC Z46. Two of the pins on this memory chip are bent outward, and Z46 is right next to Z47, one of the ribbon connection points. In order to mount my piggy-back socket, I had to carefully remove the Z46 chip and its top-mounted companion to make room for soldering.

Fortunately the local Radio Shack Computer Center has installed IC sockets so the job was easy. If you've had the modification, you probably will have to bend the two pins downward somewhat, taking care that they don't contact the pins of the 2102AN-4L directly below.

With the lower case modification, I also discovered the new character generator chip to be mounted in a new socket. Under most circumstances that would be great. In this instance, I found the socket-IC combination, potentially another low-profile socket soldered to the character generator chip, and a connector to be inserted in the socket unacceptable.

Among other things (aesthetics primarily), the package would simply be too high for available spacing between the computer board and the keyboard. So, I soldered the connector pins directly to the generator chip. I didn't like the prospect of doing so, but I had no option other than to scrap the character generator chip socket and resolder the chip back into the CPU board. That wasn't acceptable either.

That's about it. There are only two solder connections to make if you choose the nonsocket approach, and you will have to cut the pin of one IC which is certainly no big deal. No traces are cut on the board either, so it is a very clean installation.

This is especially so because the 80-Grafix board sits conveniently out of the way in the bottom of the computer case, and adhesive strips are already attached to the small PC board. Before the board is adhered in the recessed well, make sure you have checked everything out to your satisfaction. You will find the strips hold the board firmly in place, and it takes effort and care to remove the board from the well.

I found a magnifying glass handy to check out the solder connections and make sure I didn't have any solder bridges.

An Evaluation

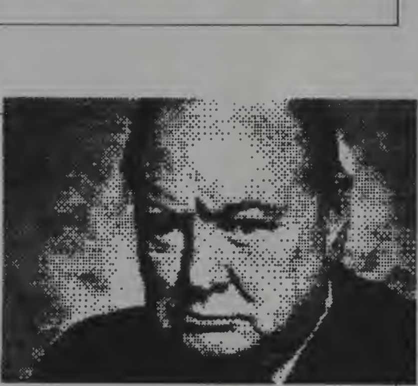
You should be aware that Programma International doesn't provide a schematic with the board. This will be a major obstacle when servicing becomes necessary at some future time. To make things even worse, chip identification has been removed from some of the ICs. Should your 80-Grafix board ever fail, you will have no choice but to remove the board and ship it back to the manufacturer for servicing.

It seems to this writer, that chip IDs and a schematic should be provided to 80-Grafix board customers. I hope the manufacturer will change its policy, for it is really in the interest of customers to be able either to service their own equipment or have it done locally if the need ever arises.

The manual doesn't tell you how to get inverse video. However, after you've fretted a bit, you suddenly discover that's one of the reasons why the demonstration programs accompany the board. The program listing tells the story, and there are inverse video program data lines waiting right there on the cassette.

I'd like to see an applications book from Programma in the future, for it would save one a good deal of time if a number of special character sets with data information were available. Also, a handy reference card would be super, along with a set of preprogrammed graphics design building-block characters that might accompany the HIRES80 software. The Arabic and Hebrew alphabets that come with HIRES80 are neat for demonstration but have little utility for many people, so I'd like to see some other more practical character sets such as electronic and logic symbols, graphic building blocks, and so forth.

The 80-Grafix board has all kinds of fascinating potential. So far all of my software works perfectly and has not been affected by the installation. The board has a lot going for it; I recommend it highly. At $149.95, it's a modest investment in a major improvement to the TRS-80. You really can have high resolution graphics icing your computer cake—and eat it, too. □



The Anadex DP 9501

Gary Mellar

Selecting a printer to use with your personal computer is quite a bit different from selecting the computer itself. Most computers offer many options and peripherals that allow you to change the original configuration as your needs and finances change. Conversely, with the exception of minor options offered by some manufacturers, the configuration and features of any particular printer at the time of purchase are what they are going to be as long as you own that printer.

With these thoughts in mind, I made a list of features that I wanted in a printer. Some of these were negotiable, others were not. The features I wanted most were: acceptable correspondence quality print for letters, expanded print capablity for highlighting reports, graphics capability, full width printing, a speed of at least 100 cps and easy interfacing to my Apple II. I also wanted a piece of equipment that was reliable, since I am not the hardware type.

After I spent a considerable amount of time comparison shopping, I ordered an Anadex DP 9501 from Consumer Computers in La Mesa, CA in mid-December 1980. It was delivered via UPS in less than two weeks.

Currently Anadex manufactures two wide-carriage printers— the DP 9500 and DP 9501—and two narrow-carriage models— the DP 9000 and DP 9001. The 9000 and 9500 are very similar, except for the carriage width, as are the 9001 and 9501. The primary differences are speed and print density. However, this article will be directed at the DP 9501 only.

Printing Characteristics

There are four print densities standard on the model 9501: 10 characters per inch with an 11 x 9 dot matrix and 12.5, 15, and 16.7 cpi with a 7 x 9 dot matrix. Print head velocity is 12 inches per second yielding 120, 150, 180 and 200 characters per second respectively. All characters may be printed double width. All printing is done bidirectionally with shortest distance logic seeking. Because it is tractor fed, it can handle paper widths from 1.75 inches to 16.8 inches with a maximum print width of 13.2 inches. Thus, at 16.7 cpi up to 220 characters per line can be printed. The 9501 can print the standard 96 character ASCII set and accepts 24 control codes. For those who might be interested, there are character fonts available as extra cost options.

Features

The 9501 has many features, most of which are selectable by pre-setting dip

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CIRCLE 255 ON READER SERVICE CARD

This is 10 Characters per inch normal and DOUBLE Width

THIS IS 12.5 C.P.I Normal Width And DOUBLE WIDTH

THIS IS 15 C.P.I. Normal Width And DOUBLE WIDTH

THIS IS 16.7 C.P.I. Normal Width And DOUBLE WIDTH

Note: g,j,p,q and y lower case letters have descenders.

Sample Print from Anadex 9501.

switches prior to power up. All are selectable via software control. In Table 1, those preceded with an asterisk are both switch and software selectable:

*10 and 16.7 cpi
12.5 and 15 cpi
*6 or 8 Lines per inch
*Top of form (front panel) switch)
Vertical tabs (up to 15)
Horizontal tabs (up to 8)
True underline
Double width printing
Graphics
Wraparound or truncate
*Auto line feed
Horizontal tabs (up to 8)
*Form feed and line feed (front panel switches)
Print width (in 10ths of an inch from 1.0 to 13.2 inches)
*Skip over perforation (1/2" – 1 1/2" or 1 to 99 lines)
*Form length (1/2" – 15 1/2" or 1 to 254 lines)

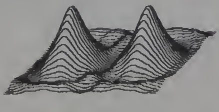
External Controls

On the rear panel are four blocks of dip switches. Two blocks of switches are used to control the features listed in Table 1. The other two blocks select the type of interface — parallel (Centronics compatible), RS-232C or 20/60 ma current loop—all of which are standard. Additionally, these two blocks set the parameters for the serial interfaces, which include baud rates (50 to 9600), word length (7 or 8 bits), 1 or 2 stop bits and parity.

Also on the back panel, is a power-type selection module which allows the user to select 100, 120, 220 or 240 volts in a frequency range of 48 to 62 hertz.

The front panel has six rocker-type switches: power on/off, paper feed, top of form set, form feed, self test and on/off line with an illuminated status indicator. The forms control switches are multifunctional; they allow bi-directional paper alignment in .014" increments.

There is a print head gap adjustment lever which allows for printing of multi-part forms, up to an original and five carbon copies. And, although it may seem trivial, there is one other feature that I really like: a manual paper advance knob that allows bi-directional paper registration in .056" increments while the power is on and almost infinite registration with the power off.

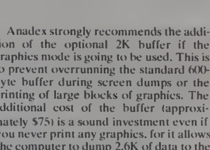


Graphics

As their brochure proclaims, the DP 9501 is a true high resolution graphics printer. It has a resolution of 72 x 75 dots per inch. With a print wire diameter of .014", it can completely blacken the full printable width (13.2 inches) six dots high per pass. Again all printing is done bi-directionally with shortest distance logic seeking. Of the nine wires on the print head only six are used in the graphics mode and each is individually addressable. The graphics mode uses ASCII codes from 64 to 127 decimal to select which print wires to activate for each print position. The paper can be advanced in one-dot increments, and the horizontal position of the print head can be defined in one-dot increments, which allows complete control of dot placement on the paper. This may sound very complex, but the operator's manual provides thorough documentation and two program examples (in Level II basic).

For those who wish to dump an Apple II high resolution screen to the printer, Computer Station, 12 Crossroads Plaza, Granite City, IL 62040, markets an excellent, easy-to-use machine language program with many features for the Apple II—Anadex user. Basically, any hi-res screen that can be saved to disk, can be loaded and printed with a variety of options.

When in the graphics mode, the character set is not available. The page length, top of form and form feed features are also lost and must be reset when leaving the graphics mode.



Anadex strongly recommends the addition of the optional 2K buffer if the graphics mode is going to be used. This is to prevent overrunning the standard 600-byte buffer during screen dumps or the printing of large blocks of graphics. The additional cost of the buffer (approximately $75) is a sound investment even if you never print any graphics, for it allows the computer to dump 2.6K of data to the printer and continue processing while the printer finishes printing. This makes more efficient use of the system, especially if you are printing files from a disk.

As a graphics printer, the Anadex is an excellent investment.

Documentation

The 79-page operator's manual is complete, well illustrated and thorough. It covers everything one must know to use the printer: from unpacking to troubleshooting. All features are thoroughly explained. The 14-page section on graphics includes two sample programs that cover the complete use of the graphics mode.

Also provided is a handy reference card with communication control codes on one side and the configuration control switch assignments on the other.

Summary

The Anadex DP 9501 is an exceptional printer at a reasonable price ($1595 list). It has all the features that I wanted most, many that were negotiable and one or two that were not even on my list.

I believe that I have covered all of the features on my most wanted list except the quality of the print. Although it is not a fully formed character type printer, the 11 x 9 dot matrix pattern at 10 cpi closely resembles the traditional type size of most typewriters and has been quite satisfactory for all my personal and professional correspondence.

Up to this point I have deliberately omitted any reference to service and support by Anadex. I thought that I would save the dessert for last.

After using the printer for about two hours, it stopped printing; the print head continued to move just as though nothing were wrong, but no printing occured. The troubleshooting manual described these symptoms exactly—faulty circuit

The Anadex DP 9501 is an exceptional printer at a reasonable price.

board or print head or both. Needless to say, I had a sinking feeling in the pit of my stomach. Although it was already past normal business hours on the West Coast, I thought I would try to reach Joe King at Anadex anyhow.

I had several very informative conversations with Joe prior to my purchase of the Anadex. He had given me a lot of technical information on both the DP 9500 and DP 9501 when I was trying to make a decision on a printer. It was these conversations that finally convinced me to purchase an Anadex. It is refreshing to find a manufacturer who is more than willing to help an end user or potential end user. Joe has assured me that Anadex is committed to support their users.

So, I made the phone call and sure enough I reached Joe King. He determined that my problem was the print head fuse and advised that if, after replacing it, it failed again, I contact the local service center in Rockville, MD for replacement of the circuit board or print head or both. It turned out to be only a bad fuse, but I called the service center anyhow to establish contact with them. They reassured me that in the event of any failures in the unit they would replace any or all parts on a walk-in-walk-out basis, which was very comforting.

In late February, the plastic window on the ribbon cartridge cracked and began leaving a slight smear on the paper. Another call to Anadex resolved this problem; a new ribbon cartridge arrived two days later via UPS Blue label.

What more can I say, except that I am exceptionally happy with the printer and the service. Anadex stands behind their product and is committed to satisfying their users. □

CIRCLE 301 ON READER SERVICE CARD

The TNW 2000

Michael Towers

Each year we go through a maniacal rite-of-spring around here called NCC; 1980, however, proved crazier than ever. As it happens, we receive demonstration units from other manufacturers to use in conjunction with our products at the show, so there is some fun to be had. This year we introduced several new products targeted at the small systems user, so we had to get some small systems hooked up to our product.

This is where Doug Gage of TNW Corp. got involved. He was kind enough to lend us a demo unit of their IEEE 488/RS-232C interface, the TNW-2000. For the uninitiated, the IEEE 488 standard was created in 1975 primarily for communication among sophisticated instrumentation. Several of the larger instrumentation manufacturers use the same standard, but under different acronyms: Hewlett Packard calls it HPIB (Hewlett Packard Interface Bus) and Tektronics calls it GPIB (General Purpose Interface Bus). As with any standard, there are departures from it; however, IEEE 488, HPIB, and GPIB are essentially the same thing.

There are several useful descriptions of the IEEE 488 standard around including the IEEE's document (strictly for the masochistic) and Hewlett Packard's part number 59401-90030 (for us mere mortals). Basically, it is a 16-line communication/control bus which allows up to 15 instruments to be connected in parallel with one another. There are three classes of devices: talkers, listeners, and controllers. Any and all of the devices may be talkers/listeners, but usually only one device is the controller. This device (a computer, for instance) tells the others whether they are talkers or listeners (if they are capable of doing both), and further, addresses the devices which are on-line with both primary and secondary address information. This clever little feature allows, for example, a host machine (controller) to address a multimeter (talker), take a data sample, and then, via a secondary address to the same device, change the scale and take another reading. Ah, but I digress—for more complete information on the IEEE 488 bus, read some of the excellent material available which describes it.

Meanwhile, back at the ranch, we have a Commodore PET computer which we need to attach to our products to show customers that it can be done. Of course, we also did the same thing with Apple and Radio Shack, but they made it easy by providing an optional RS-232C interface. Commodore does not, so it was necessary to locate a PCM which did. Several manufacturers sent us their products, but after evaluating each, I decided that I liked the TNW device best. Here's why.

First of all, we needed a two-way device in order to interface a PET to both our plotters and our digitizers. This limited the market right away—there are several one-way devices available which are useful for printers and such, but there is a paucity of two-way devices. A further constraint was Commodore's quirk of not supporting all IEEE 488 standard commands. They didn't include the Service Request Enable, Serial Poll Enable, Group Execute Trigger, and some others. However, these can be implemented with a little software hocus-pocus. Keithley Instruments has an excellent application note which shows how to do it. Commodore also chose not to equip their machines with an IEEE 488 standard connector, but this is really only a minor annoyance. In short, all we needed was a nice, simple, inexpensive IEEE 488 to RS-232C interface that would work well with both PETs and IEEE 488 standard devices. What we got from TNW was an attractive, unobtrusive device that requires no "trick" software or other such kludges.

The documentation accompanying the TNW-2000 tells you everything you need to know about the installation, configuration and operation of their equipment with both standard IEEE 488 devices and the Commodore PET. While the manual itself isn't the finest piece of printing I've ever seen, it was written by someone who speaks both computerese and English. It includes sections on operation and installation, schematics, enough code to make the device work, and contingency information in case it doesn't. Also included are two useful sections on the IEEE standard, the 488, and the EIA standard, RS-232C. Virtually everything you need to know about the IEEE 488, RS-232C, and PET specifications is included (Commodore also has a "modified" ASCII code, which is explained). The first thing the book tells you is to plug it in, turn it on, and forget it since the unit only draws a few watts of power (which comes from a standard utility outlet, not the host machine).

The IEEE device address, parity, PET or standard ASCII, and high/low range baud rate are selected by a dip switch on the rear panel. Once set, it should not be necessary to use them again.

The next thing is to run the short little program to set the baud rate (assuming a PET):

```
10 OPEN 1,4,1 : J=1 : K=1
20 FOR I=1 TO 255: A$=A$+"A" :
   NEXT
30 T=TI: FOR I=1 TO J: PRINT#1,
   A$:: NEXT : T=TI-T
40 PRINT "BAUD RATE IS"; INT
   (168300*J/T), "PASS"; K
50 K=K+1: J=J-SGN(T-200): IF J=0
   THEN J=1
60 GOTO 30
```

This program gives a continuous baud rate calculation displayed on the PET's screen. While this program is running, it is necessary to a) select high/low range on switch 1 of the dip switch on the rear of the device and b) adjust the port R29 (also on the rear panel) to the desired baud rate.

Once the device has been configured, one has but to plug the RS-232C device into the interface and press on. The interface is configured as a DCE device, so if it is to be used in conjunction with a modem or some other device configured as DCE, then a null modem cable must be fabricated—all of which is covered in detail in the manual. In most cases, however, this probably won't be necessary. And, happily, the TNW-2000 provides standard connectors for both the IEEE 488 and RS-232C ports as well as a mating connector for the non-standard PET IEEE 488 port. Data is throttled through the RS-232C port via RS-232C standard control lines RTS, CTS, and DTR (all of which are also explained in detail).

All things considered, the TNW-2000 seemed to be the best suited to our needs because it was relativly inexpensive, required no external "special" software, was simple to hook up and create, was at the same time complex enough to do several things well, and was attractive in appearance and design. In short, I think it's a pretty good value for $229. It is available from TNW Corp., 5924 Quiet Slope Dr., San Diego, CA 92120. □

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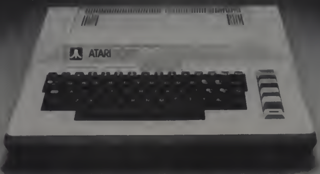

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CIRCLE 114 ON READER SERVICE CARD

TC-8 Cassette Operating System

First came the expansion interface and disk drives for the TRS-80. Next came the Exatron Stringy Floppy (ESF) to serve as the "poor man's disc." And now there is the TC-8 Cassette Operating System (COS) to serve as the "poor man's floppy."

Manufactured by JPC Products Company of Albuquerque, NM, the TC-8 COS is sold in kit and and assembled form. The kit is easy to assemble, and the $30 saving is well worth the hour or two of effort required. I would strongly recommend that anyone in the bifocal days of his life also acquire and use at least a 3X magnifier for identifying the values of the small parts and examining the soldered connections. There is an ample supply of solder in the kit so the only items you need are a 30-watt soldering iron, a pair of small wire cutters, and a little time end patience. The unit comes with its own power supply, connecting cable and utility program tape. Yes, this device requires 550 hex bytes of memory to operate.

Nothing needs to be said about the inefficiency of the TRS-80 cassette interface. Changing the recorder to operate and receive data from the I/O port increases the speed of data transfer almost three times and increases the reliability of the transfer. The TC-8 COS connects to the I/O port with the included cable.

I had a bit of difficulty loading the utility program tape, but after 15 minutes of fiddling with the volume control on the recorder I got the program loaded. The TRS-80 format tape of that same program now loads in slightly less than 15 seconds. The original program tape is in three parts: the MONITOR, the full UTILITY,

Robert C. Kyle, 3940 Oakland Ave. So., Minneapolis, MN 55407.

Robert C. Kyle

and the modified UTILITY which is a short version of the full UTILITY. The modifed UTILITY and the full UTILITY programs are loaded as one program. The short version has its own starting address. If your memory is precious and you need every byte you can lay your hands on then just type KILL and ENTER and you have your TRS-80 back to its old self again. Even though you KILL the utility program, you still leave the debounce program in high memory (45 bytes).

The utility program supports 21 commands, four of which are file commands (OPEN, CLOSE, INPUT#, PRINT#). Basic programs are saved and loaded under the SAVE and LOAD commands. The SAVE command must be accompanied by a "filename," which can be any group of eight or less alphanumeric characters. This means that all of your programs can have real names which are recognized by the computer. The LOAD command does not require a filename, but if there is one, the program will search for it on the tape while listing the names of all the other programs it encounters. For example, let's say you have a game tape (TC-8 format) with BLACKJAK, POKER, CRAPS, and STARTREK programs stored. If you type LOAD "CRAPS" and ENTER (assuming you are starting at the beginning of the tape) your screen would look like

```
LOAD"CRAPS"
$BLACKJAK   $POKER   $CRAPS
READY
```

which would mean that the CRAPS program was loaded and ready to run. You could also type RUN "CRAPS" which would enable the program to be loaded and executed immediately.

What if you have a TC-8 format tape and don't know what's on it? Easy: just load it in the recorder and type LOADN. On the screen will be printed all the program names that are on the tape, but the programs will not be loaded. To exit the LOADN function just hit the BREAK key. System tapes are stored and loaded under the PUT and GET commands. Since they will only work with system tapes you can store system and Basic programs on the same tape. The "$" signifies a Basic program and the "%" is used for the system programs. If you GET or PUT a Basic program or SAVE or LOAD a system program you will get an SN ERROR message.

The TC-8 COS supports two recorders which can be addressed separately. The default is to recorder 1.

On power up MEMORY SIZE? is answered with 31400 and the utility program is entered under a standard SYSTEM procedure. The full program is executed by typing the / ENTER at the second ?*. If you want the short version just type /32150 and the screen will show BOOT READY. At this point you unplug the recorder from the TRS-80 cassette port and plug it into the TC-8 unit. If you have many programs to convert to the TC-8 format I would suggest you buy, beg, or borrow another recorder, connect it permanently to the TC-8 unit and leave the original recorder connected to the TRS-80 cassette port. That way there will be less wear and tear on the plugs and

COMPARISON TABLE

EXATRON STRINGY FLOPPY	TC-8 CASSETTE OPERATING SYSTEM
COST $250	COST $120 (kit $90)
Special wafer cassettes w/ continuous loop	Standard audio cassettes Continuous loop cassettes available
4 bytes computer memory used	550 hex bytes computer memory used
Programs saved by numbers (1-99)	Eight character "names" allowed for saved programs
Booted on power up	Load short utility program (approximately 15 seconds) Disconnect recorder and plug into unit
Supports 7 units with individual addresses	Supports 2 recorders with individual addresses
Supports 7 commands—4 file commands	Supports 21 commands—4 file commands
Data files specified	Data files not specified
Requires special Data program (1K)	Included in utility program
SAVE and LOAD speed approximately 1K/second	SAVE and LOAD speed approximately 1K/second

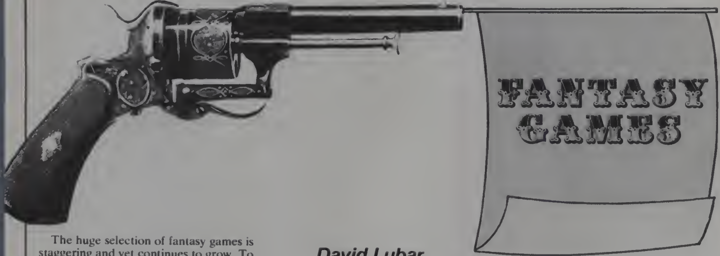
cord. Be sure to buy another cassette connecting cord for the second recorder. It is not necessary that your second recorder be a CTR-80 since the TC-8 supports a RESET command which frees the rewind and fast foward on any recorder that has these functions tied to the motor control jack. When the RESET command is used, the recorder motor remains on until you hit the BREAK key.

File management is similar to disk except that files cannot have names. The user controls the name by making it the first entry he writes to the file. Only one file can be OPEN at a time so there is no interchange between files directly. This can be handled through software subroutines.

The TC-8 COS stands up to comparison with the ESF admirably. If one considers the $90 kit price, the comparison becomes weighted excessively in favor of the TC-8. Therefore the comparison of features is based on the assembled price ($120) of the TC-8, which is about one half the cost of an ESF unit.

The manual accompanying the unit is excellent and the company is very receptive to any comments, suggestions, or complaints you have. Their address is JPC Products Company, 12021 Paisano Ct., Albuquerque, NM 87112. (504) 294-4623. □

CIRCLE 303 ON READER SERVICE CARD



David Lubar

The huge selection of fantasy games is staggering and yet continues to grow. To date, I've been killed innumerable times, gained and lost vast treasures, dabbled in magic, battled monsters, and generally had a great time. This month, as promised, a look at a game that is not for the squeamish, a glance back at an old favorite, a look ahead at more new games, and whatever else befalls us.

Mind Your Manors

As Adventure games become more elaborate, we tend to overlook some of the early games. While the forerunners might not be as sophisticated as newer programs, they can still be worth playing. So, before going on to newer games, here's a look at an old favorite.

creative computing
SOFTWARE PROFILE

Name: Beneath Apple Manor
Type: Fantasy
System: Apple II
Format: Cassette (16K)
Floppy Disk (32K)
Language: Integer Basic
Summary: Good fun, replayable
Price: Tape $19.95, Disk $19.95
Manufacturer: Quality Software
666 Reseda Blvd.
Suite 105
Reseda, CA 91335

Beneath Apple Manor, from **Quality Software**, is addictive enough to be investigated by the FDA. This granddaddy of games bears a copyright notice from way back in 1978. In it the player roams through rooms and corridors, picking up treasure and fighting monsters. The familiar traits of strength, intelligence, dexterity, and body (vitality) are present. The goal of the game is to find the golden apple. At the start, you select the number of rooms per level (from two to ten), and the difficulty (from one to ten). The commands are given as single keystrokes; you can move, attack, grab a treasure, or perform several other acts. The program adjusts the monsters on each new level, keeping the game challenging. Conversely, if you get clobbered on one level, the next level will be easier. The starting point for each level is the main staircase. Whenever you return to the staircase, you have the options of trading experience for other attributes, buying weapons or armor, getting a brain scan, or moving to the next level. The brain scan is insurance against being killed. After death, you are resurrected to the status of your last scan.

The game makes good use of the various attributes. The greater your strength, the more damage you can do in combat. But each attack reduces your strength. You can also zap monsters, but each zap reduces your intelligence. And if your intelligence is too low, you won't be able to teleport out of bad situations.

The tape version is somewhat complicated to use. You have to load several binary programs and a Basic program. Whenever you want to move to a new level, you have to reload a program. But, since you can spend a long time on one level, this isn't too much of an inconvenience.

Beneath Apple Manor is the sort of game which you can play for extended periods. And, after tiring of it, you can always come back later for another romp at a higher skill level.

Quality Software also markets *Fracas*, a game of exploration, combat, and treasure hunting for up to eight characters. The program is designed to accept future scenarios, and comes with one scenario, Faroph Town, on the disk or tape. At the start, you generate characters, either selecting characteristics or letting the computer roll for you. Each character receives a certain amount of strength, skill, movement and vitality, and a weapon class. You are free to select armor class, but each point of armor reduces movement and skill. Characters can start at the beginning of the scenario, or be placed randomly.

creative computing
SOFTWARE PROFILE

Name: Fracas
Type: Fantasy
System: 32K Apple II or II Plus
Format: Tape or Disk
Language: Applesoft or Integer Basic
Summary: Well done, will be nice if future scenarios become available
Price: Tape $19.95, Disk $24.95
Manufacturer: Quality Software
6660 Reseda Blvd.
Suite 105
Reseda, CA 91335

During play, each character has six options. He can run (no one walks in Faroph Town), going up to the limit of his movement allowance. He can rest, attempting to regain lost vitality. He can attack, retreat, or dodge. Finally, he can get a status report. Rooms, players, and other goodies (or bad guys) are displayed with color-coded lo-res graphics. On each turn, the contents of a room are displayed and identified. Players choose one of six alignments. They can't fight players of the same alignment. The computer con-

Software for the Apple II and Apple II Plus*

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Cassette - $22.95 Diskette - $24.95

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LINKER by Don Worth
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- Produces a map of all loaded routines, giving their location and the total length of the resulting module
- Contains a library of subroutines including binary multiplication and division, print text strings, delay, tone generator, and random number generator

Linker works with virtually any assembler for the Apple II. Requires 32K of RAM and one disk drive.

Diskette - $49.95
Manual Only - $19.95

FASTGAMMON™ By Bob Christiansen
Sound, hi res, color, and musical cartoons have helped make this the most popular backgammon playing game for the Apple II. But don't let these entertaining features fool you — FASTGAMMON plays serious backgammon. Runs on any Apple II with at least 24K of RAM.

Cassette - $19.95 Diskette - $24.95

METEOROIDS IN SPACE™
By Bruce Wallace

We have taken our popular space game, formerly called Asteroids in Space, and made some important improvements. To accent these improvements we have given it a new name — METEOROIDS IN SPACE. Your space ship travels through a shower of deadly meteoroids. If your ship is hit, it will be destroyed, so you use your laser gun to blast the meteoroids. Big meteoroids shatter into smaller meteoroids when hit, and the smaller ones are usually faster and just as deadly. From time to time you will encounter an alien space ship whose mission is to destroy you, so you'd better destroy it first. All the action is displayed in fast, smooth, high resolution graphics, accompanied by sound effects. You now can control your ship using one of two options — the Apple game paddles or the keyboard. One of the game paddle buttons controls the laser fire. In METEOROIDS IN SPACE, the spaceship's velocity gradually decreases unless more thrust is applied, adding an element of control. Also new to this version is a hyperspace feature — translate instantly to another spot in the galaxy. The game is over when five of your ships have been destroyed. An additional ship is added for every 10,000 points you score. Runs on any Apple II with at least 32K of RAM and one disk drive.

Diskette - $19.95

ASTROAPPLE™ by Bob Male

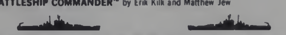
Your Apple computer becomes your astrologer, generating horoscopes and forecasts based on the computed positions of the heavenly bodies. This program offers a delightful and stimulating way to entertain friends. ASTROAPPLE produces natal horoscopes (birth charts) for each person based on his or her birth data. Any two people may be compared for physical, emotional, and intellectual compatibility. The program is written in Applesoft BASIC with machine language subroutines. It requires either RAM or ROM Applesoft and at least 32K of memory.

Cassette - $14.95 Diskette - $19.95

FRACAS™ by Stuart Smith
A fantastic adventure game like no other! Up to eight players can participate in FRACAS at the same time. Journey in the land of FAROPH, searching for hidden treasure while warding off all sorts of unfriendly and dangerous creatures. You and your friends can compete with each other or you can join forces and gang up on the monsters. Your location is presented graphically and sound effects enliven the battles. Save your adventure on diskette or cassette and continue it at some other time. Both integer BASIC and Applesoft versions included. Requires at least 32K of RAM.

Cassette - $19.95 Diskette - $24.95

BATTLESHIP COMMANDER™ by Erik Kilk and Matthew Jew



A game of strategy. You and the computer each start out by positioning five ships of different sizes on a ten by ten grid. Then the shooting starts. Place your volleys skillfully — a combination of logic and luck are required to beat the computer. Cartoons show the ships sinking and announce the winner. Sound effects and flashing lights also add to the enjoyment of the game. Both Applesoft and integer BASIC versions are included. Requires at least 32K of RAM.

Cassette - $14.95 Diskette - $19.95

Also by Don Worth

BENEATH APPLE MANOR — Adventure. Uses Integer BASIC
Cassette - $14.95 Diskette - $19.95

BABBLE - Fun with words, sound, and graphics
Cassette - $19.95 Diskette - $24.95

QUALITY SOFTWARE
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(213) 344-6599

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trolled characters have different alignments. Whenever a character is next to another character of different alignment, an encounter occurs. During encounters, you can fight, retreat, or rest. The success of combat depends on a character's skill, strength, weapon rating, and armor class. If you vanquish an opponent, you get all his gold. Winning gold can increase your experience, allowing you to gain skill or strength, but it can also reduce your skill or movement.

There are several levels to Faroph Town, with trap doors and doors that seem to teleport you to other areas. If you find yourself in one of the tougher areas before gaining enough experience, you could be in trouble. One of my favorite characters was destroyed in a premature encounter with a small dragon and King Boogaloo (there are touches of humor laced through the scenario).

There is no ending, *per se*, to the game. Once you have explored all avenues, the program allows you to continue wandering through empty locations. To offset this, the instructions contain suggestions for possible rules. Solo players might want to try gathering a certain fixed amount of treasure, or defeating a certain monster. Groups might try competing for the most gold, continuing until only one survives, or starting at random locations and trying to meet. Once you've explored the whole scenario, there are no surprises left, but you can always try going through with a weaker character, or gathering more loot.

All's Wells That Ends Well

Krell Software markets two fantasy games with interesting premises. *Time Traveler* allows you to wander through fourteen eras, attempting to gather hidden time rings. Each ring has a special power that can aid you on your quest. The areas you explore are represented by a text grid which is displayed whenever you give the "map" command. As you move through an era, you can attempt to gain allies, fight enemies, and discover the location of the rings. The game is interesting, and the encounters change on replay. Various misfortunes can hinder your progress, including capture by the local power group. You might be imprisoned, tortured, or otherwise mistreated, but that's part of the lot of a time traveler. Written in Basic, the game takes a few seconds to respond to commands, but the wait is not unbearable.

Whenever you enter a time period, you have to choose which side you want to join. In Egypt, you can be a Pharoah or a Priest, in colonial America, you can be either British or Colonial. Your choice will effect how you are treated by other people of that era. Guards might let you through or block your way, depending on your allegiance.

creative computing
SOFTWARE PROFILE

Name: Time Traveler
Type: Fantasy
System: 16K Apple with Applesoft, PET or TRS-80
Format: Tape
Language: Applesoft, PET Basic, or Level II Basic
Summary: Different, time trip type treasure hunt
Price: $24.95
Manufacturer: Krell Software
21 Millbrook Dr.
Stony Brook, NY
11790

creative computing
SOFTWARE PROFILE

Name: Sword of Zedek
Type: Fantasy
System: 16K Apple with Applesoft, PET, TRS-80
Format: Tape
Language: Applesoft, Pet Basic, TRS-80 Level II Basic
Summary: Ra is a quitter
Price: $24.95
Manufacturer: Krell Software
21 Millbrook Dr.
Stony Brook, NY
11790

Was it fun? Mostly. The change of format from other fantasies was nice, giving a bit of variety. The randomness, allowing replay, is a plus, though I'm sure that after a certain number of plays, the game will begin to acquire a familiar ring.

Sword of Zedek is the other fantasy game from Krell. This is similar to *Time Traveler* in format, but your travel is across space rather than through time. You have to win allies from among the fantastic creatures of the land, then find the evil Ra and defeat him. While exploring the land, you must try to persuade creatures to join you. You can also hire kings or banes. But if you hire any creature's bane, that creature will not join you. The land is represented by a text map of nine by ten, and a second, smaller map of the underground area. *Sword of Zedek* didn't seem to have the variety or excitement of *Time Traveler*, and Ra rolled over and died a bit too easily.

Squish, Ick

Bob Liddel is the creator of a game called *Death Dreadnaught*, that is definitely not for the weak of heart. You find yourself on a wrecked space ship (there sure is a lot of litter in the universe); your primary goal is to get out alive and your secondary goal is to keep from doing anything that will get you killed. Though done with just text descriptions, the game is quite graphic. Every conceivable word for "icky remains of slaughter" has been used

in the room descriptions, from mundane maggots to bizarre terms with slightly medical overtones. How is the game? Not bad. The inner logic is there, along with the other trappings of a good adventure.

creative computing
SOFTWARE PROFILE

Name: Death Dreadnaught
Type: Fantasy
System: TRS-80 Model I
Format: Tape or Disk
Language: Machine Language
Summary: Gooey, gorey game
Price: Tape $14.95, Disk $19.95
Manufacturer: The Programmer's Guild
P.O. Box 66
Peterborough, NH 03458

And, if you get killed, you can go back to the start without loosing any of your possessions. That avoids the tedious process of regaining everything, and takes less time than loading in a saved game.

The interesting part about *Death Dreadnaught* is that, after a while, I found myself ignoring the gruesome descriptions and concentrating on the game. The gory stuff quickly becomes just words to glance through. There are some nice touches in the program. At one point, I tried what seemed to be a clever way to get through a certain locked door. To my surprise, the method worked. To my chagrin, I found that I definitely didn't want to get through that door. Fortunately, I was resurrected with all possessions. If you are bothered by violence or crude descriptions, stay away from *Death Dreadnaught*. Otherwise, it's as good as any other adventure of this type.

Highland Computer Services markets some nice fantasy programs for the Apple. The games come on disk and require 48K with Applesoft. *Oldorf's Revenge* allows you to explore an underground world drawn in hi-res graphics.

creative computing
SOFTWARE PROFILE

Name: Oldorf's Revenge
Type: Fantasy
System: 48K Apple with Rom Applesoft, Disk Drive
Format: Disk
Language: Applesoft
Summary: Good romp through underground world
Price: $19.95
Manufacturer: Highland Computer Services
14422 S.E. 132nd
Renton, WA 98055

The program, though in Applesoft Basic, runs fast, and rarely accesses the disk, thus speeding responses even more. This game introduces a neat twist. You can be one of seven characters: cleric, thief, elf, magician, wizard, gladiator, or strongman. Each character has special commands only he can execute. For instance, thieves can open, unlock, pry, or pick things. Only gladiators can fight. During play, you can switch from one character to another, but no character can be used more than five times. The first goal is to get enough gold to allow you to cross the toll bridge. Once across the bridge, you can save the game in progress. The ultimate goal is to find the exit from the caverns and leave with at least 300 points. The pictures, while not works of art, are good enough to increase the quality of the game.

creative computing
SOFTWARE PROFILE

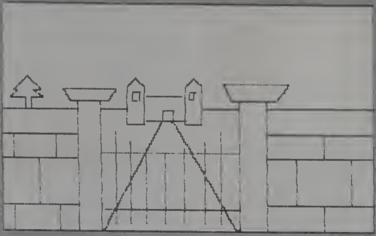
Name: The Tarturian
Type: Fantasy
System: 48K Apple with Rom Applesoft, Disk Drive
Format: Disk
Language: Applesoft
Summary: Good concept, nicely executed
Price: $24.95
Manufacturer: Highlands Computer Services
14422 S.E. 132nd
Renton, WA 98055

The Tarturian uses the same multi-character concept, but adds an interesting extra. Each character can be killed by a certain type of monster. The instructions contain the remnants of an old document that shows the footprints of each monster, giving you some chance to change characters before getting killed. There is also a new character. The mortician follows your group, burying members who are killed. In *The Tarturian* you can use each character up to ten times.

creative computing
SOFTWARE PROFILE

Name: Creature Venture
Type: Fantasy
System: 48K Apple with Rom Applesoft, Disk Drive
Format: Disk
Language: Applesoft
Summary: Hunt through house in hi-res
Price: $24.95
Manufacturer: Highland Computer Services
14422 S.E. 132nd
Renton, WA 98055

I was also sent a preliminary sample of *Creature Venture*, which takes place in a haunted house. Again, the pictures were good, and the game was fun. A bit of animation spiced up play. Like most games of this type, there are points where you can get stuck with nothing to do. Until you find the required solution, you can't go on. Still, for those who like adventures, this one is a good buy. □



The entrance to Uncle Stashbuck's mansion from *Creature Venture*.

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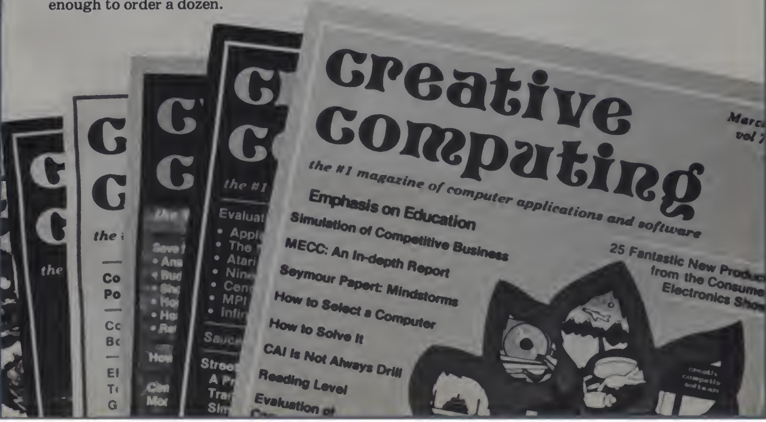


From Avalon Hill...

COMPUTER WARFARE

Dale Archibald

Dale Archibald, 1817 Third Ave. N., Minneapolis, MN 55405.

I hate to admit it, but I'm even more of a game addict than I am a computer addict. I've played chess, checkers, GO, backgammon, and parchesi. I've played poker, pinochle, euchre, and bridge. I've played dungeons and dragons. I've played electronic handheld games as a reviewer. I've competed on video games. And I've played war games (a.k.a. simulation games,) ever since the 1960s. I've also been lucky enough to play many of the computer games currently on the market.

When I learned that Avalon Hill Game Co., the *grande dame* of the simulations business, was to publish its first set of computer games, I thought it would be the event of the year for both gamers and computer owners. After all, the firm has been publishing games for over 20 years. (Avalon Hill Game Co., 4517 Harford Rd., Baltimore, MD 21214.)

The firm's first offerings came on the market in mid-summer 1980, selling for around $15 each. The games include **Nukewar, B-1 Nuclear Bomber, North Atlantic Convoy Raider, Midway Campaign**, and **Planet Miners**.

Each game is on a cassette which includes an original and backup for the Apple II with Applesoft Basic, TRS-80, and PET. I tried to run the games on my 16K Apple II Plus. It said on the box and on the instructions that it takes "16K Memory Beyond Basic" for the Apple.

Avalon Hill batted about .400 with me when I tried to load the games. Nukewar loaded on the first try. Convoy Raider took five tries, and finally loaded from the backup. Midway Campaign beeped, and beeped again, but the cursor wouldn't come back on. B-1 Bomber printed ERROR regardless of volume; and Planet Miners went OUT OF MEMORY.

A second tape recorder loaded B-1 Bomber, but to run Midway Campaign and Planet Miners takes a 20K Apple II Plus. The 16K of free memory beyond Basic means just that.

Convoy Raider

Looking at the games in chronological order, North Atlantic Convoy Raider is first. It's a simulation of the 1941 attempt of the British Home Fleet to sink the Bismarck. You command the Bismarck while the computer controls the Hood, King George V, Rodney, and Prince of Wales. It also controls convoys the Bismarck should sink.

The weight of world opinion goes against whichever country fires first.

The display is a 12 x 12 grid, each grid zone representing 10,000 square miles. Ships are represented by the first letter of their names.

Strategic and tactical are the two types of turns. A strategic turn prints a map showing convoys and battleships currently spotted, plus damage to the Bismarck, remaining fuel, time, weather conditions, etc. It then asks for commands regarding the heading on which you wish to sail.

A strategic turn contains one or more tactical turns approximately 30-60 minutes long. When a change occurs in the tactical situation, the computer will print out a message such as KING GEORGE V SPOTTED, then wait about four seconds. If the player presses the space bar during this time, a new strategic turn can be entered. This allows the Bismarck to change directions to escape battle, for instance.

Once the Bismarck is within range of a convoy, it automatically fires. When

within range of a British battleship, it will ask for a target ship. Then the player sits and watches while the battle goes on. So really, the only choices the player can make are: which direction to go, and whether to fight or flee.

Weather and day/night conditions are factors to be considered. The game is weighted heavily in favor of the British. Don't lose the instruction book. The game itself won't prompt you to remember that H changes heading.

Midway Campaign

Midway Campaign is the next stop in our order of battle. It's June, 1942, in the Pacific. Four Japanese carriers are heading toward the tiny island of Midway, supported by cruisers and an invasion force. The U.S. has two carrier forces in the vicinity, and Midway itself has every airplane it can scrape up.

As I mentioned earlier, this game takes a 20K Apple II Plus. It uses the same type of grid Convoy Raider uses. The carrier forces are Task Force 16, with the Enterprise, Hornet, and cruisers; and Task Force 17, the Yorktown and cruisers.

This game does prompt the player. The U.S. forces are commanded by the player, and since it's an air battle the planes are all-important. Midway is considered a carrier. Combat Air Patrols are set up around each one to form a protective screen in case of Japanese attack. The remaining aircraft are armed and ready to launch against the Japanese fleet. Prime target, of course, is that carrier force.

Your carriers are also top priorities. Their aircraft can make strikes up to 235 nautical miles away, while yours can only go 200. You have to stalk their carriers, and hope yours go undetected. Sometimes you know when you're spotted; other times you aren't told. Once you launch the strike, you can only sit and watch. When your planes return, they go below to refuel and rearm. This takes a full move, and there's nothing you can do while they're down.

Playing the game again to write this review, I was able to sneak in behind their carriers and launch an attack that sank all four of them. It was the first time I've won!

Nukewar

The next game in time is Nukewar, a favorite among visitors to my house. Two 8 x 8 grids represent two countries for which you select names.

Your object is to build up bomber, missile, submarine and anti-ballistic missile bases on the grid coordinates while the computer-controlled enemy does the same. You can also spy or attempt to declare war before the computer does.

The building campaign is limited by time. The year the game begins is random, between 1956 and 1965. Missile subs aren't allowed until 1965, ABM bases until 1970.

The first strike hits the other country's forces on the ground. You may also hit enemy cities. The weight of world opinion goes against whichever county fires first.

Missile subs go to sea, immune from attack. Bomber bases launch fighter-bombers. They're 20 per cent tougher as fighters, and will knock out incoming bombers. Bombers that survive that attack, and any ABM attacks, will hit targets of opportunity. You don't need to know where enemy bases are for this to happen.

You order missile attacks—and submarine missile attacks when the subs are in location—by grid coordinates. Often, the missiles will drift, so don't count on one missile for one target. Some will miss nine out of ten times.

Claw for altitude—drop the big one—and get out of there.

During defense the information scrolls so fast it's unreadable. During battle, the premier of the computer country keeps calling to negotiate. If you're stronger, she may agree to a truce. The winner is the side with the greater population surviving. Cities have 11 million people, other non-bombed grid locations one million each.

B-1 Nuclear Bomber

Best of the games is B-1 Nuclear Bomber. The scenario starts with a Russian attack on the U.S., and you're pilot of a B-1 out of Thule.

Ask the navigator for a course to your chosen target, check the status of your ship, and name your course and altitude. You must fly low to miss radar. As you go roaring along, surface-to-air missiles (SAMs) and MIG fighters are launched to intercept. You have six Phoenix missiles, electronic countermeasures (ECMs), and can take evasive action. The deeper into Russia you fly, the stouter her defenses become. To add to your problems, every time you use ECM, it works less well.

Nuclear air blasts flash on the screen as you roar along. When you arm the bomb, enemy activity really picks up: Their detectors can more easily home in on you. Claw for altitude—drop the big one—and get out of there.

If you do reach Thule, and have enough fuel to land, you may find your crew has been seared by radiation. This is an exciting game, with good prompting.

Planet Miners

Finally, far in the future, Planet Miners sets your family against three others (either human or computer-controlled) in an attempt to gain mining concessions on planets throughout the solar system.

Each player has five ships manned by crews of varying capabilities. But one ship has to stay on earth to deal with various ownership squabbles, claim jumping attempts, etc. The others travel throughout the system to make claims, claim jump, attempt sabotage, and do all the things normal interplanetary businesses do in the course of a day.

The object, of course, is to amass the greatest number of claims by the end of the 40th move, or when the earth's Mining Council calls a halt to the proceedings. Shades of the gold rush.

Unfortunately, although it's the only multi-player game in this set of five, it's achingly dull.

All five of these products have a touch of the board game about them. Perhaps as board games they would be acceptable, but as computer games they fall short. They don't take advantage of any of the computer's capabilities except the bookkeeping function and—on the Apple, at least—some squeaks and bleeps to signify battle. You don't see ships, aircraft, planets, or anything but letters. All the maps are like that. Only B-1 Nuclear Bomber uses graphics, and that just flashes the screen to signal an atomic air burst.

B-1 is also one of two that have any sense of time as a factor, as defending MIG fighters and SAMs come into range. Nukewar uses time only to the extent that the player never knows when the machine will make its onslaught. At least there's some tension in these two. As far as the others are concerned, you could leave and make a sandwich while you consider you next move!

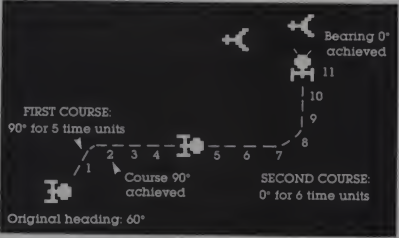
Please understand, I'm not suggesting that these games should have all the bells and whistles of arcade games; I know they are strategy simulations. I do feel, however, that they would benefit greatly from more suspense, and more play value. As it is, they seem to be neither fish nor fowl.

But there are good things about them. They're inexpensive, and they'll run on machines with small memories. Best of all, they're giving Avalon Hill a chance to test the water, to see what type of computer games are most popular—to learn what should and shouldn't be done.

Also, consider this: just the fact that Avalon Hill has published these games gives the entire computer game business an aura of familiarity. Non-computer retailers, such as game stores, toy stores and book stores, that would never have thought of handling computer games a year ago, may reconsider just because AH is involved. □

The Warp Factor

David Lubar



This Alliance cruiser needed two successive MS (move ship) commands to describe this S-curve. The first MS command turns the ship to bearing 90° for 5 time units. The second command alters course to 0° for six time units. At least one more MS commands would be required to complete the remaining 5 time units of the turn.

creative computing
SOFTWARE PROFILE

Name: The Warp Factor
Type: Space Fight Simulation
System: 48K Apple with Rom Applesoft, Disk Drive
Format: Disk
Language: Applesoft
Summary: Excellent strategy game
Price: $39.95
Manufacturer: Strategic Simulations
465 Fairchild Drive
Suite 108
Mountain View, CA
94043

The early programs from **Strategic Simulations** had a reputation for a long lag time between turns. In complex situations, there could be waits of half an hour or more while combat results were produced. Thus, when *The Warp Factor* arrived for review, I was hesitant to look at it myself. I just couldn't envision spending hours in space fights that didn't take place in real time. Luckily, I did take a look at the game. *Warp Factor* is great. Those of you who liked playing Star Trek, but got bored with the simplicity and redundacy of the game, have a new addiction in store.

Warp Factor places you in command of a starship or fleet of ships. You can be part of any of six interstellar nationalities: Alliance, Reman Marauder, Imperial Pirate, Klargon Empire, Independent Starbase or Freeman. Different nations have different ships at their command. Each ship has a specific type of armament and shields, as well as a different turning rate, acceleration, and mass. This is no simple aim-and-shoot simulation. The ship must be commanded with skill and intelligence, integrating all features and capabilities of the vessel into each decision.

Play proceeds in phases. After choosing a scenario, and getting your ship or ships, you go through a series of commands. Let's assume you are controlling an Alliance Heavy Cruiser. The first command, after checking the status of the ship is Set Display. The display can be centered either on the ship or at galactic coordinate 0,0. The view can be in any of eleven magnifications from a close-up minus 5 to a wide-angle plus 5. Once you see the location of the enemy, you can make battle plans. Energy is allocated to shields, weapons, transporters, electronic counter measures, and electronic counter counter measures. Certain weapons have to be charged for several turns before they can be fired. Each ship has six shields, which can be individually reinforced. During energy allocation, you also choose the speed of the ship for that turn.

The next key area is the Fire Weapons command. In this segment, you choose which weapons to fire in up to three separate salvos. For example, the Alliance Heavy Cruiser can fire three phasers and two torpedoes during the first salvo. Then it can fire its remaining phasers and torpedoes at a different target during the second salvo, and fire nothing during the third. For each salvo, you have a choice of firing according to range, time, or last moment. This is where skill truly enters the game. Let's say you are close to an enemy ship. You might have already completed a portion of your movement phase (more on that later) and noticed that you fly past the ship on time segment eight. Using the specific-time option of the Fire Weapons command, you could choose to fire all rear-facing weapons at time-segment eight. Most weapons have a limited field of aim, and it does no good to fire a weapon forward if the target ship is behind you. Some weapons hit (or miss) their targets in the turn they are fired, others, such as drones and plasma torpedoes, might travel for more than one turn before reaching their target.

The final crucial command area is Move Ship. Here, you can specify direction of movement for up to sixteen time segments. After any move, the position of the ship is replotted. You can move a part of the distance, see where you end up, then go to the Fire Weapons command. Your turn is over after the last move segment has been entered.

Then comes your opponent's turn. If you are playing another human, he will go through the same command series. If you are playing against the computer, it will take a minute or so to enter commands.

Next come the results. The computer will think about things for a minute or so. If there is combat, it will inform you and ask you to hit return. This is nice since it allows you to leave the room and not miss anything. Combat results are reported as text, and there might be a wait of several more minutes between segments of the report. But the wait never seemed unduly long.

I first tried the game with one ship against a computer ship. Next, to see how much longer the wait became, I played with four ships against four on the computer. Surprisingly, the wait didn't increase much.

There are five scenarios available, four of which are for one player. Most scenarios allow a choice of ships, thus greatly expanding play possibilities. Along with the disk, you also get a thirteen-page instruction manual, and a set of sheets illustrating and describing the available ships.

Warp Factor is excellent. A lot of thought, strategy, and planning is required if you want any chance to beat the computer. The control over the ship, and the many facets of navigation and combat, make the game extremely challenging. If you have a bit of patience and don't mind waiting a few minutes for results, and if you want to take part in a contest requiring plenty of thought and skill, *Warp Factor* is definitely worth buying. □

Apple Graphics Utilities

David Lubar

Back in the early days of the late seventies, very few people could cope with placing graphics on the Apple. We all knew it was possible, but the prospect of creating shape tables by hand was enough to dampen anyone's spirits. The picture began to brighten with the appearance of graphics utilities. *Creative Computing* published a shape table generator written by Gary D. Dawkins. Steve Wozniak of Apple furnished a shape-table program in his **Wozpak**. These programs not only allowed easy design of shapes, they also stored a series of shapes in a table, taking a major element of drudgery out of programming. Now, there are many graphics utilities on the market. Five of these programs are covered below.

Local Color

Bob Bishop, who is to Apple graphics what Wilbur and Orville were to flight, has moved the coloring book into the computer age with *Micro Painter*. The system allows you to fill in hi-res pictures wlth twenty-one colors. The disk includes eight drawings. When the program starts, you select a picture, either from the disk or from any disk with a drawing on it. The picture is placed on the screen, along with a flashing crosshair controlled by paddles.

creative computing
SOFTWARE PROFILE

Name: Micro-Painter
Type: Color-fill Program
System: 48K Apple II or II Plus, Disk Drive
Format: Disk
Language: Integer or Applesoft Basic and Machine Language
Summary: Electronic coloring book
Price: $34.95
Manufacturer: Datasoft, Inc.
16606 Schoenborn St.
Sepulveda, CA 91343

Colors are selected with two keystrokes. Normal blue is BB, light blue is LB, dark blue is DB, and so on. Once a color is selected, a push of the paddle button causes an area to be filled. The color spreads out in a diamond pattern, stopping whenever it encounters a black line. Once an area has been colored, it can't be easily recolored. The paint mode only functions against a white background. Colored pictures can be saved on disk.

Since most drawing programs and graphics tablets produce a white line on a

Drawing by Saul Bernstein on *Micro Painter*.

black background, Bishop has included a command which produces a negative of the screen. Thus you can draw with any graphics program, save the picture, bring it back under Micro Painter, and reverse the colors to obtain black lines on a white background.

Micro Painter also has a microscope mode which expands the picture to seven and a half times normal size. In this mode, you can examine and change individual pixels. This is handy for patching up small, enclosed areas that can't be filled in the normal mode.

It seemed to me that Micro Painter would be an ideal program to get people interested in computers. It is easy to use, fun, and produces immediate, observable results. A friend, who had very little computer experience, tried the program and had no difficulty following the instructions, which are clear and well written. She was, however, very amused by the microscope mode and the line in the instructions which said, "The Paint Brush and the area around it have been magnified seven and a half times!" After she stopped laughing, she explained that the microscope she uses at work has a resolution of 100,000X. Her amusement quickly gave way to absorbtion as she went on to color several drawings.

For beginners who want to have a new kind of fun with the Apple or advanced programmers who need to color pictures, Micro Painter is an excellent program. The instructions also include a short program in Applesoft which allows you to draw with the paddles.

Paddling Around

On Line Systems, known for their excellent graphic adventures, sells *Paddle Graphics*. This set of programs, based on software developed by Versa Computing, allows you to draw on the screen, color areas, create shapes, and add text to a picture. Drawing with the paddles is tricky, but, with a bit of practice, you can obtain nice results. There is also an automatic mode where the line moves at a steady speed, and direction is controlled by a single paddle. This allows for free-flowing lines such as signatures. Line drawing commands allow you to specify two points and obtain a straight line between them, or draw a horizontal or vertical line delimited by two points. In other words, you can move diagonally, but obtain a horizontal line which starts at the first line and moves until it is at the same x coordinate as the second point. The documentation explains how to use this mode to draw perfect rectangles. The add-text routines are very nice. Text can be placed horizontally or vertically, in either Greek or English font. There are five sizes of text, and text can be added to any picture.

Drawings can be filled with any of twenty-one colors. The fill routine doesn't always color the entire area, and several fills are often needed. The best results seem to come from placing the cursor in

ON-LINE systems

PRESENTS


Missile Defense

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MISSILE DEFENSE

$29.95

In this arcade-quality action game you command the Nation's missile defense center to defend against a foreign missile attack. As missiles drop from the sky, you must shoot them while trying to protect your six cities and three missile bases. An automatically esculated skill level ensures that the better you get the tougher Missile Defense gets!

- Fast machine language. Hi-Res animation and sound!
- Rapid fire capability - mark and shoot at many targets simultaneously!
- Works great with keyboard only, paddles or joystick!
- Separate controls for all three missile bases!
- Bonus cities awarded for high scoring!

WARNING: This game has been known to cause addiction and should be used with extreme caution!!!

THRILOGY

OF GAMES $24.95

The object of BUSTOUT is to bust through the wall of bricks to get behind the wall and eliminate the wall of bricks. Behind the wall, eliminating the bricks is much faster. The ball starts slow but will soon go faster than you may be able to handle also when you get behind the wall, your paddle will get smaller ! A beginner's mode is provided for less experienced players.

BUSTOUT loads Integer BASIC and transfers all important subroutines into Assembly Language. Since BUSTOUT utilizes both Hi-Res pages and Assembly Language programming, its graphics are very fast and very smooth.

The object of SMASHUP is to run over all of the dots on the track before the computers car smashes into your car. Beware! He is out to get you!

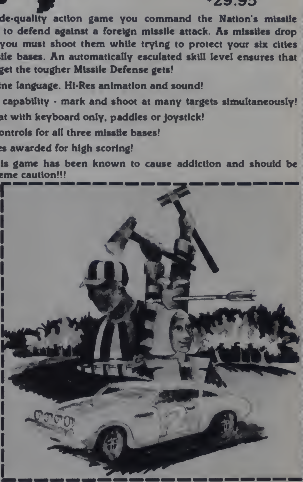
Begin the game by choosing one of the four skill levels and then slip behind the steering wheel of your car. Get the feel of the throttle, and then really start to rack up the points.

SMASHUP loads into Integer BASIC and then transfers all important subroutines into Assembly Language, making it's Hi-Res graphics very fast. SMASHUP has unique sound effects also in Assembly language making it even more lively.

You are WILLIAM TELL. You only have five arrows with you and to get a perfect score you must shoot the two apples off the tree and you must also shoot the apple on the boy's head three times. Don't aim too low! You might kill him and not receive any points!

The flight of the arrow depends on the tension on the bow when the arrow is launched After each shot, the boy will comment about your shooting. Did you kill the boy? Well push the paddle switch and start over.

WILLIAM TELL is an Integer BASIC game using Hi-Res graphics and is fun for all ages.


Thrilogy


Sabotage

SABOTAGE

$24.95

In this innovative game, you take command of a powerful gun base to shoot helicopters and aircraft out of the air. Beware! The opposing have plans to Sabotage your base. Can you defend yourself from the rain of bombs and paratroopers and keep your base in action?

- Written in Machine Language - quick animation and sound effects.
- Hi-Res color graphics.
- Works great with paddle or keyboard control.
- Conventional and controlled missiles.
- Rapid fire capability - mark and shoot at many targets simultaneously.
- Automatically esculated skill level - the better you get, the tougher "they" get.

All of these Arcade Games are available now at your local computer store. They will run on any 48K Apple II or II Plus with a disk drive. To order direct, send the purchase price plus one dollar for shipping to: **ON-LINE SYSTEMS • 36575 Mudge Ranch Road • Coarsegold, CA 93614**

Visa, Master Charge, C.O.D. or Checks Accepted **209-683-6858** Dealer Inquiries Invited

CIRCLE 248 ON READER SERVICE CARD

Utilities, continued...

the middle of the largest blank section. After this, any corners or fragments that were missed can be filled.

> **creative computing**
> **SOFTWARE PROFILE**
>
> **Name:** Paddle-Graphics
>
> **Type:** Drawing and Shape Utility
>
> **System:** 48K Apple with Rom Applesoft, Disk Drive
>
> **Format:** Disk
>
> **Language:** Applesoft and Machine Language
>
> **Summary:** Versatile utility
>
> **Price:** $39.95
>
> **Manufacturer:** On-Line Systems, 36575 Mudge Ranch Rd., Coarsegold, CA 93614

Once a drawing is on the screen, it can be saved to a shape table. This table will contain not just the shape, but also the color, so filled shapes can be stored. The shape is saved by first marking its boundaries. A box is drawn around the shape and the program slowly designs the table entry. For a large shape, this can take a long time. Once the shape is saved, it can be recalled and displayed with all the usual commands, including changes in rotation and scale. By pressing the space bar, you can leave an image of the shape anywhere on the screen, allowing a shape to be used as a brush. Commands are also included for freezing the x or y coordinate, making it easier to place a series of shapes on a line.

Paddle Graphics is a very useful program. The text mode alone is almost worth the cost of the package.

Penguin Graphics

Mark Pelczarski (alias the Magic Penguin), a very talented Apple programmer, is the author of two graphics packages. *Magic Paintbrush 4.0* contains programs for drawing on the screen and for developing shape tables. There are three drawing modes. The line mode draws a line between any two points. By holding down the paddle button as you move the cursor, you can obtain curves. The fill mode also draws lines, but keeps a constant origin for the lines, allowing you to fill in an area with a series of lines. The paint mode provides a choice of nine brushes with which to paint lines or fill background. Since these brushes are stored as a shape table, the user can define his own brushes.

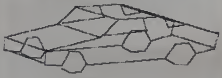
The shape creation routines are very nice. There are two modes. Quickdraw uses the paddles and is designed to be fast but not accurate for intricate shapes. The shapes are designed in lo-res, but can be viewed at any time on the hi-res screen. While viewing them, the paddles control scale and rotation. The other method uses keys to plot the shape. While plotting, the scale and rotation can be changed using the paddles. This is a very versatile system. For instance, you can start with a scale of four, where each point is plotted four times, then shrink the shape. The ability to alter the shape in mid-plot allows a great deal of control over the final product.

> **creative computing**
> **SOFTWARE PROFILE**
>
> **Name:** Magic Paintbrush 4.0
>
> **Type:** Drawing and Shape Utility
>
> **System:** 32K Apple with Rom Applesoft, Disk Drive
>
> **Format:** Disk
>
> **Language:** Applesoft
>
> **Summary:** Good for designing shapes
>
> **Price:** $29.95
>
> **Manufacturer:** Co-Op Software, P.O. Box 432, West Chicago, IL 60185

As a bonus, the disk contains five games using shapes that were created with the Magic Paintbrush: Applesoft Invader, Slot Machine, Collision, Dogfight, and Sailboat Race. The Slot Machine program is nicely done. The Invader game is rather slow, but has a hilarious ending. Collision is a good simulation of the arcade game. The games are in Basic, and don't run as fast as machine-language versions, but they make a nice extra for the package.

> **creative computing**
> **SOFTWARE PROFILE**
>
> **Name:** The Complete Graphics System
>
> **Type:** Drawing, Shape, and 3-D Utility
>
> **System:** 48K Apple with Rom Applesoft, Disk Drive
>
> **Format:** Disk
>
> **Language:** Applesoft and Machine Language
>
> **Summary:** Excellent 3-D utilities, good shape creator
>
> **Price:** $59.95
>
> **Manufacturer:** Co-Op Software, P.O. Box 432, West Chicago, IL 60185

If you take *Magic Paintbrush*, add three dimensional graphics routines, color fills, hi-res text, and other graphics routines, you'll have Mark Pelczarski's *Graphics System*. The three-dimensional utilities verge on the phenomenal. A figure can be rotated through any dimension, distorted, moved, or scaled. You can experiment with the two figures provided on the disk or create your own. Different figures can be placed on the screen and be manipulated separately. Two-dimensional shapes can be constructed using the panel utility, then be brought into the 3-D section where vertices can be joined. The distortion subroutines were the most fascinating. Any vertex of the figure can be stretched or shrunk through left/right, forward/back, or up/down distortion. At any point, the figure can be edited, changing the length of any of the lines, or changing the connections of the vertices. It takes a few minutes to get used to the routines for creating figures, but they are well constructed. Overall, the entire 3-D set is graced with easy input routines.



A 3-D Image by Mark Pelczarski.

The disk includes a program that shrinks a hi-res picture into one quarter of the screen. I should also mention that while the color-fill routines are not as effective as those in Micro Painter, and sometimes require several fills to cover the desired area, they do allow for over 100 colors.

Shape Up

Shape Master from **Sensational Software** is a utility specifically designed for creating and manipulating shape tables.

> **creative computing**
> **SOFTWARE PROFILE**
>
> **Name:** Shape Master
>
> **Type:** Shape Utility
>
> **System:** 48K Apple with Rom Applesoft, Disk Drive
>
> **Format:** Disk
>
> **Language:** Applesoft
>
> **Summary:** Complete utility for creating and altering shape tables
>
> **Price:** $24.95
>
> **Manufacturer:** Sensational Software, P.O. Box 789-M, Morristown, NJ 07960

Shape creation is executed on hi-res grids, allowing each point to be seen in an expanded size. The user has a choice of five plotting grids, from 13-by-23 to 39-by-69, and two methods of plotting. The vector method consists of moving a cursor through the grid, and indicating which points on the path should be plotted or not plotted. This works along the lines of the traditional method where the programmer defines a series of vectors and indicates which points on the path should be plotted. At any time, you can reverse the moves, deleting the series or part of the series. The graph method allows for more flexibility. Here, individual points on the grid can be selected for plotting. Once all the desired points are chosen, the program constructs a table entry for the shape. This frees the user from worry about drawing the shape as one continous series of points. Shapes created previously can be brought into this mode for editing.

Once shapes have been created, they can be saved to a table or displayed. An entire table can be displayed, or individual shapes can be seen, scaled, and rotated. Adding to the utility of the program, any shape or group of shapes in a table can be reversed, giving a mirror image. These reversals can replace the original shapes or be appended to the table. Also, shapes within a table can be shuffled.

The authors, Doug Green and Matt Clark, have included four games and two graphics demos on the disk. The games are slow, but give good examples of what can be done with shape tables. The demos are superb. One shows a front or side view of an Atat walker from *The Empire Strikes Back* clumping along the screen. The other shows a Tie Fighter which can be rotated through three dimensions as it moves. The instructions are clear and thorough, covering all aspects of the program, and explaining how to use shapes in other programs. Available August 1981.

End of the Rainbow

Obviously, each of the above programs has different virtues and flaws. *Micro Painter* is the best for filling areas, and the microscope mode allows for fine detailing. If you already have a good drawing program and shape-table creator, *Micro Painter* is the way to go. *Paddle Graphics* offers versatility, giving you a good variety of capabilities. The fill routines aren't as polished as those of *Micro Painter*, but they are adequate. The only thing it lacks is a method of developing shapes point by point. *Magic Paintbrush* has an excellent shape creator, and the use of definable brushes adds a lot of flexibility, but the fill routines are awkward. *Graphics System* offers a good variety of utilities, including excellent shape table routines, and is the only one of the above which includes 3-D utilities. However, it is expensive, and designed for the serious programmer who has need of these tools. *Shape Master* is designed strictly for shape tables, with no drawing routines, but it handles its functions very well. If your main concern is designing shapes for use in other programs, *Shape Master* has a lot to offer. Depending on what you already have, and what your prime needs are, each of these programs has something to offer. □

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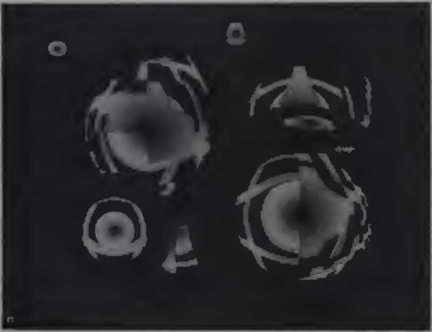
"Oh gosh. I knew there was something else I was going to mention."

The Creation of Paintings/Programs



Duane M. Palyka

The following is an excerpt from Artist and Computer *by Ruth Leavitt © 1976 Creative Computing Press. The author, whose computer portrait appears on the cover of this issue, is now at the Computer Graphics Lab at NYIT.*

Computer memory is an electronic surface—a thin sheet consisting of millions of small electronic elements called bits, each with its own electronic field which can be measured plus or minus, one or zero, white or black. As these bits are set by a computer program one can stand away from this surface and see clusters of bits, patterns of bits. These bit settings can form different gray levels, shapes, and visual images.

This is not totally imaginary discourse. A device called a frame-buffer was invented for just this purpose: to allow bits of a computer memory to reflect themselves on a visual device—the principal one being a color TV monitor. The computer memory is continuously scanned and displayed on the monitor; the way the bits are set reflects in the way the three color guns excite the phosphors on the tube surface. Programs can be written to change these bits dynamically and therefore give instantaneous color feedback on the TV monitor.

When a computer lends itself so easily to visual artistic exploration, why should it be restricted to engineering uses? Why should any separation be made between this and other artistic devices? The computer artist need not know about his medium below the plastic level any more than the painter has to know about the chemistry of his paints. The plastic level of the computer art medium, however, includes programming; but programming is just as plastic a medium in its own right as paint and brush, and can be thought of in a direct visual sense when coupled with an accommodating hardware device like a frame-buffer.

Both the creation of paintings and the creation of computer programs are the creation of objects—objects constructed out of ideas, concepts, and craftsmanship. The aim is a finished work with strong structure, patterns, imagery, and textures. A painting can be considered "clean" if devoid of meaningless shapes and forms. A program can be considered "clean" when the code has no meaningless instructions. Good structure in a program can bring as much esthetic satisfaction as good structure in painting. The code and structure of a program reflects the personality of the person generating it. Both programming and painting are problem-solving processes to which each person has his own approach.

Actually, in painting more emphasis may be placed upon the subconscious as the source of images and ideas. Not to exclude the fact that leaps of the imagination are needed to generate creative ideas in both media, programming is basically a logical process which utilizes an individual's conscious mind. Because of this difference, painting can reach a more mystical level of awareness—a depth of consciousness which we can experience but not explain. This does not mean that works of art are not logical, far from it. It is because the most creative works of art have such a logical basis that the computer fits in so well with the creative artistic process.

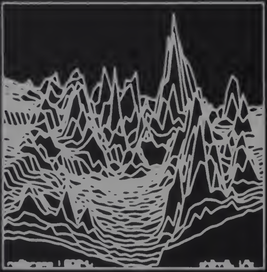
It is interesting to note that as artists go, besides renaissance painters, Escher is one of the favorites. This is because Escher renders a reality on a very conscious level with deviations made on a strictly logical basis to keep it interesting. There is little leakage from the unconscious into Escher's images.

What this thought process lacks is the realization that leakage from the subconscious can make the images even more real in spite of the fact that they now deviate from the strictly-observable real world. This deviation personalizes the images by allowing the viewer's imagination to get in sync with the artist's on a 'non-understood' subconscious level.

One can also have the computer simulate a traditional art medium with which the artist is familiar and leave it to the artist to make the transition from the medium he knows to the new medium on his own terms. The computer is very good at simulation and, coupled with a frame-buffer, this particular simulation is simple to implement. Using an electronic pen and tablet for input, the artist can be provided with a medium similar to acrylic painting. He can watch on a TV monitor a flow of color reflecting his hand and pen movements on the tablet. In fact, he can even select the brush sizes he wishes to use.

An advantage that this medium has over acrylic paint is that the artist can change the medium to suit his own personal artistic needs through programming. As the artist learns to program he can see the development and change of his medium and, hence, of his images.

The computer art medium can also help with the artistic risk-taking process. When an artist makes radical changes to his painting based on new thoughts and ideas, he risks destroying the painting to produce a highly-creative work. Giacometti and Matisse had the guts to wipe out hours of work to start afresh on the same painting. This can be a difficult thing for an artist to do. Giacometti developed a process of taking a painting to completion, wiping it clean, painting it again, wiping it again, etc. until he reached a state where he liked it or just gave up. A problem occurs when a previous stage of painting has the best result but there is no way of retrieving it. Picasso found the desire to have two paintings developed to a certain indentical state then each taken to completion in different directions. These tasks can be made easier with the computer art medium. □



Landing The Nostromo

Alan Sutcliffe

THE LANDSCAPE

In the summer of 1978 I was working with System Simulation Ltd. in London. They were asked to produce several sequences of computer animation for a space-fiction feature film already being made by 20th Century Fox. I had heard of one or two people connected with it: Ridley Scott was director and one of the actors was Ian Holm. A lot of Americans were also involved.

It turned out the film was called *ALIEN*, but that did not mean much to us then. I was given a brief look at an early script and asked to work on a section where the space-craft was coming in to land on an unknown planet. The atmosphere was opaque but some kind of future radar allowed a computerized view of the terrain on a screen in the command deck. I imagined, in my simple way, that there would be dialogue to put this over

Hey, look at the Ramdac screen, Skipper.

Looks damn hilly down there.

Here's a flattish patch.

That'll have to do.

Obviously I had seen too much Star-Trek; *ALIEN* was much more subtle than that. No explanations, no apologies. But I didn't know that—and I didn't need to know it—until I saw the film a year later. I was asked to make the computer output look like computer output, to make 30 seconds of landing in rugged country with a flat area.

The screen was to be surrounded by meaningful-looking animated displays showing altitude and angles and such.

Alan Sutcliffe, 4 Binfield Rd., Wokingham Berkshire, RG11 1SL England.

The hardware to be used was a Prime 300 connected to an FR 80 from III which can plot directly onto cine-film. Running on this system at the SRC laboratories in Oxfordshire was the software animation package, Frolic, developed by C. Emmett.

My program was written in Fortran with calls to Frolic subroutines. Apart from general interest, you might ask why write about this in *Creative Computing*? A system costing over £1/4m is nobody's personal computer. The answer is that the two main parts of the program that I shall describe, the generation and display of the landscape and putting up the character displays, can both be realised on a small machine, provided that it drives a device with vector graphics.

Magic Mountains

"Magic Mountains" was my pet name for the project. The original scheme was to digitize a model landscape, but one day a block of about two cubic yards of polystyrene turned up in the office, its top carved into all sorts of fantastic shapes. Its overhangs and near-caves would have defeated the method I had planned to perform hidden line removal. In any case it was decided that it would be too time-consuming and too tedious to measure this model in detail and enter several thousand data values to represent it. I would synthesize the mountains from nothing. The whole process for the landscape consisted of three main stages:

1) *Generation*. On an equally spaced x-y grid of 50 x 50 points, a value of z was generated for the height of the ground at each point.

2) *View point*. This three-dimensional information was converted, for each of a series of angles and distances, into two-dimensional positions on the display screen. The series of angles corresponded to the view from the descending spaceship. The conversion and the control loop for the animation were performed by calls to Frolic, and will not be described here in detail.

3) *Hidden line removal*. For each view, the scenery was displayed by drawing a line through each set of points with the same x-values in the original three-dimensional form, but leaving out any

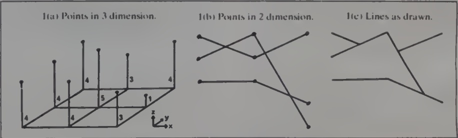


Figure 1. Three forms of the landscape data.

Nostromo, continued...

lines that were visually below the horizon formed by the nearer lines. On this scheme, a flat plain would be represented by a set of parallel lines running across the screen. Finally the lines had to be plotted, a trivial step using Frolic.

Figure 1 shows the form of the data after each of these three steps for a sample part of the grid.

Generating the Landscape

There were two parts to the landscape, an underlying terrain and an arrangement of mountains laid on top of it. I used the sum of four separate mathematical expressions to make the basic structure. There was a valley running from front to back achieved by applying a flattened sine-wave. There were three small ridges running diagonally across the area. From front to back the ground first rose then flattened out and rose again, indicated by a bunching together of the lines in the upper-middle of the pictuere. This area was overlaid with mountains that it hardly showed in the final version. Notice that applying an equal slope all the way from front to back would have no effect except to alter the apparent angle of view—all that matters is the relative slope in different parts of the picture. The fourth term in the expression was a small random perturbation of each point, to add a little texture and interest.

Figure 2 shows the landform that resulted from this calculation. It also shows an example of one of the hills on top of this. There were 400 hills altogether. Each normal hill covered an area of 5 x 5 grid points, and had a central peak with roughly symmetrical sides. About 20% of the hills were made into mountains covering 7 x 9 grid points, with a higher limit on the size of the peak. About 15% of the hills were made asymmeterical, and a further 20% were made into holes rather than hills by changing the sign of the expression.

The placing of the hills was controlled to give a roughly flat mountain-free area at the front of the picture, and also so that the hills at the back tended to be somewhat higher than those at the front. Apart from this, the locations and sizes of the hills and their detailed shapes were determined by calls to the random function. Figures 3 or 4 show two views of the final landscape. Since two or more hills could overlap there are some double peaks, flat tops, and small ridges and groups of peaks. These came by chance and it was not necessary to program them separately.

It may be thought that this method was over-elaborate. But I have found in the past that in simulating both sounds and appearances, a wealth of detail lends an air of verisimilitude. Geology, like much else in the world, is the result of a rich variety of complex processes. Some of the detail may be hardly perceptible, like the three ridges which can only be seen at the edges of the picture. Some, like the rise and flattening of the land already noted, may not be seen at all. This does not matter. The computation is only performed once, and no harm is done save a small amount of redundant coding and computing. In this case, neither mattered. The whole routine to generate the landscape took less than 40 lines of Fortran. Using a small system on which time and space would be more important, it would be easy to weed out the redundant parts.

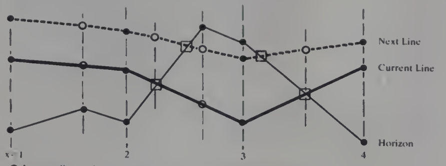


Figure 5. How intermediate points arise on the horizon.

The main change I would be likely to make implementing something like this on a small system would be a reduction in the size of the 50 x 50 array, depending on the storage available, the type of display hardware and the purpose.

Control

The second major step in the whole program was a loop of 720 frames (30 seconds at 24 frames a second) from diminishing height and viewing angle to get the two-dimensional data for each viewpoint. It says a lot for the power of the Frolic system that this took about ten statements.

For each of these frames it was necessary to do the hidden-line removal and plot the visible lines. Remember that the lines to be plotted run roughly across the screen in the x-direction. It is possible to use lines running diagonally, or two sets of orthogonal lines to give a more solid looking surface. This was not done really because there was no time for it. On reflection the method we used worked well, as the output has a solid four square computer look, not too fancy for an old space-freighter.

Hidden Line Removal

The logic of removing hidden lines worked like this.

1) Draw the nearest line: nothing obscures it. This line now defines a horizon—anything above it will be visible and anything below it will be hidden.

2) Inspect in turn each segment of the next line. If it does not intersect the horizon, draw it or not depending on whether it is wholly above or below. If it intersects the horizon, calculate the point of intersection, and draw the segment that lies above the horizon, ignoring the remainder. The visible parts of the line will thus have been drawn.

3) Revise the horizon by adding the portions of the line that have just been drawn, retaining the existing horizon for the other portions where the current line was hidden.

4) Return to step 2 until all the lines have been dealt with.

Figure 5 shows a section of horizon intersecting the current line. Although the horizon starts as a series of points on the original grid, with the same number of points as a single line (50), each new intersection adds a new intermediate point to the horizon. In this case the number of points on the horizon increased from 50 to almost 200. When space is scarce it is important to estimate a realistic maximum for this. A subsection of the current line must be compared with each section of the portion, so that intermediate points on the current line have to be computed with the same x coordinate as those on the horizon.

One awkward little problem I bypassed: Suppose a point on the horizon and a point on the line coincided. The way my algorithm was coded this would need a significant piece of programming to cater for an event that might occur only once or twice, or not at all. If the points did coincide—they had to be compared to see which was higher—then I added a tiny amount to the value of the point on the line for this viewpoint only. The change was visually insignificant, and the intersection, if there was one, was moved a fraction sideways.

Several other simplifications were built into the way I had chosen to deal with the data. Notice that there was no perspective applied to the view: all points with the same y-coordinate in the three-dimensional data lay on the same vertical line on the screen. This was possible because the screen contained nothing to scale any feature of it. Had there been any recognizable parallel lines, representing canals or buildings for example, perspective would have been necessary. That would have meant that the grid points would no longer lie on neat vertical lines in the display, so that many more subdivisions of the lines and the horizon would have been needed, calling for correspondingly more computation and storage.

In the same way, perspective would have meant clipping the viewed scene to fit the rectangular screen, entailing both redundant computing for points of the picture (at the extreme left and right of the foreground) and extra logic to deal with points down the edges of the screen where clipping occurred. All this was avoided, although the method could have been extended to deal with perspective if this had been vital.

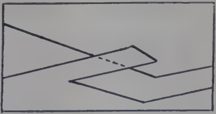


Figure 6. Overhang: a problem for hidden lines.

A limitation of this way of removing hidden lines not so easy to overcome is that vertical and overhanging surfaces are not allowed in the terrain. For each x-y point in the plane there can be only one point on the ground, only one value of z. Allowing two or more values for a point would require a much more elaborate algorithm for hidden line removal, as there would no longer be a simple horizon with visible above and hidden below. The horizon might snake back in an overhang, below it visible and above it covered, as shown in Figure 6.

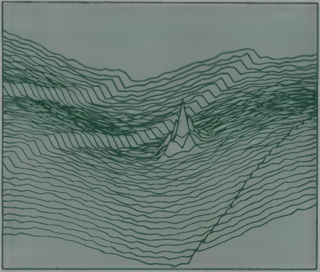


Figure 2. The basic terrain.

SEVEN-SEGMENT ALPHABET

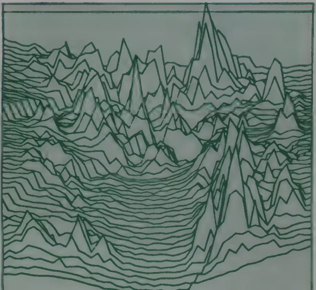
Character Display

The screen was to be surrounded by messages and other character displays such as the name of the ship, "Nostromo." For this I wrote a routine that put up a seven-segment character of any size in any position. Figure 7 shows the characters I used—a mixture of upper and lower case.

Some characters are not easy with seven segments: I did not have k, m, q, v, w or x. This did not matter, as I simply avoided using them, except for m, which was needed in the name of the space ship. For this I cheated, and simply drew an extra line down the middle, outside the normal routine. Apart from this the system was simple and uniform. 2 and Z were the same as 5 and S. Parameters were set for the position, height and width of the character, and another for the character to be used. The routine could be called for a sequence of characters to form a word, all with the same size parameters and fixed spacing between them: 1/3 of a character width.

For each character,the seven segments were always traversed in the same order, as shown in Figure 8. For each character in the set there was a string of up to seven values which determined whether the segment was to be drawn or not. In terms of the normal plotter commands, 1 meant PLOT and 0 meant MOVE. I also used -1 to indicate that there were no more segments to be plotted, in place of a string of redundant MOVE commands at the end of a code. In the code

a is represented by 1111011
b is represented by 11111-1
c is represented by 1101-1



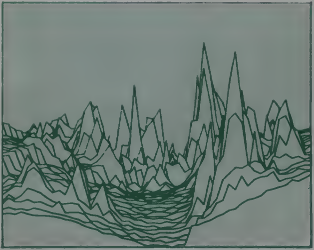


Figure 4. A view near landing.

Figure 3. Looking down on the landscape.

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Nostromo, continued...

There were over 100 characteristics in the picture altogether, so it was worth making it easy to move and change them. For variety, different sizes of character were used, and different proportions: some words tall and thin, others short and fat. Two examples are shown in Figure 9.

Animation was easy. To indicate height, for example, I simply counted down the frame numbers so that the final frame was at ALTITUDE 0. Each number, never greater than 999, had to be converted to its decimal digits for display. much more sophisticated that you will not be able to tell a synthesized image from one captured with a camera. That is a problem in the real world too, and it is time we had a regulation that all simulations be clearly marked so. But not in space movies.

In the end, all my effort on characters was in vain. It was a rather boring typeface, a cliche even, for a computer display. The director apparently thought so, too, since in the final version it was not used. Only the magic mountains were used in close-up. It was strange, going to the London previw not knowing how much, if any, of my stuff was used. I think there were four clips, each a second or two, just long enough to see the animation of the descending view.

There were one or two disappointments. Every program is capable of having bits added to it. I was not able to use color for different parts of the display. For reasons I never discovered that facility in Frolic would not work in the context of my program, though it did elsewhere. That's software for you. I wish there had been time to try out different landscapes, but the first complete run of the program was the one we had to use. Maybe that was just as well, since first thoughts are often best, and enhancements are not always

Figure 7. Seven-segment character set.

Other displays, like ANGLE, were given arbitrary values. I added a minus sign to the character set for a bit more variety. Another type of animation was to make a word appear progressively. One new character every six frames, say, would give a rate of four characters per second, until the word or phrase was complete, then rub them out and start again. This gave the appearance of an urgent message. Another dodge was to synthesize a row of buttons or lights, each one consisting of several concentric letter "O"s. These could be flipped on and off from time to time. I also used a large letter "O" to put a rectangle round the display of the landscape, round some groups of character displays, and around the entire picture. This was simpler than drawing a rectangle, since I had the mechanism ready made.

The whole array of messages and characters was very busy, and did not make any special sense in detail. The animated parts went at different speeds, some too fast to follow, some hardly changing at all. It made enough sense that nobody could look at it for a few seconds on the cinema screen and say that it was not the kind of thing done that would be on a spacecraft control deck, or that it could not be done by a computer. After all, it was done by a computer.

Figure 10 shows a complete frame from my final output on 16mm film, showing all the messages around the simulated mountains.

It was one of the aims of the *ALIEN*, to produce effects, including ours, which were authentic, and I think it succeeded in this. Certainly many a space drama has been spoilt for me by unbelievable computer displays of meaningless flashing lights. One of the problems you might think about later, but not in the heat of action during the film, is that since it is set sometime in the future, displays will be so

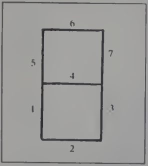


Figure 8. Order of plotting segments.

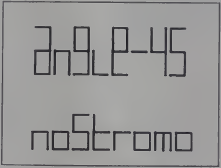


Figure 9. Example messages.

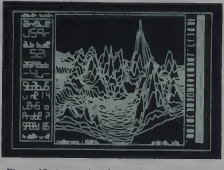


Figure 10. A complete frame showing messages.

improvements. There was a bug that should have been fixed. At one point, the top of the tallest peak spilled over the line representing the edge of the display screen, as there was no clipping. You can see this in Figure 2. It didn't seem to matter: either that bit wasn't used, or perhaps no one but me noticed this detail.

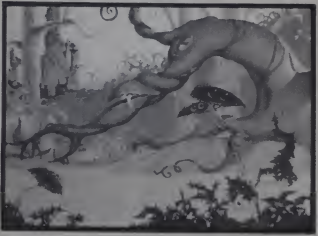
In all, it was a very satisfying project to work on. It was completed in about three months, working part time. To give some idea of the scale of the project, the size of the code was roughly as follows, given in pages of Fortran, about 45 lines to a page.

Overall control and set up	1
Generating the landscape	1
Character routine	2
Calling the character routine	4
Routine to remove hidden lines	6
Total	14

This included a modest number of comments—since the project was short-lived and I was not expecting anyone else to read the code, the minimum of documentation was needed. That was one of the best things.

My special thanks are due to C. Emmett who wrote Frolic and helped me enormously to make good use of it.

One last remark about the animation. Looking at the still graphics, the hills and peaks appear a bit confused. As soon as the view point begins to move over them, however, the three-dimensional feeling is much stronger, and the various parts separate. The two main peaks on the right hand side in Figure 3 do not have much depth between them. But when you have arrived at this view from Figure 2, where the separation is clear, when you seen the foreground loom up, and many of the hills between the two peaks disappear, then the sense of looking at a solid world is much greater. □



Pictures for an Exhibition

David Lubar

A Moving Experience

Imagine a speck of light on a television screen. The speck hangs in space for a moment, then dances forward in a graceful arc. The speck moves closer and takes form; a solid object, a piece of plastic molded in abstract form, rotates on the screen, spinning, twisting, hovering. But the object isn't real. That is the wonder of it. The above scene is just a small hint of the incredible work being done at the New York Institute of Technology. They have what may be the most advanced computer animation facilities in the world. The other day, I was given a tour of this wonderland. There is much to tell, and the urge to rave and babble is strong.

Our party of three was greeted by Louis Schure, who explained that the lab was divided into stations, each of which worked on one aspect of animation. The heavy work was handled by a bank of DEC 11/34's with hard disk drives. Mr. Schure, a friendly, articulate person with a background in both business and computer science, took us upstairs to the first station. Our path crossed several areas where people and computers were doing astounding things.

Outlines

Our first stop was the Tween station. Howard Spielman, a cartoonist, animator, and artist, showed us the first steps of the animation process. In front of him was a screen and an electronic tablet, to one side was a keyboard and another screen. Mr. Spielman's work consists of developing the characters and objects that will appear in animated sequences. In traditional animation, each frame is composed of several celluloid acetate sheets, or "cels." A new cel has to be drawn for each change of the object. This is a lengthy process, or was until the computer took over. First, the number of frames is decided. To give us a taste for what the system can do, Mr. Spielman drew an airplane on the right of the screen and assigned the shape to frame number one. Then, using the electronic tablet, he put the plane on the left side and assigned that picture to frame thirty. In a few seconds, the computer had interpolated the position in-between, producing thirty frames of animation. The frames could be viewed at any rate from slow motion to a blur. While this was impressive, it was just the beginning.

The word "Hi" was placed on the screen in large block letters. This was assigned to frame sixty. Then the word was reduced to a speck and assigned to frame one. Again, the computer interpolated the frames in-between. The result was a word that moved from the background, growing larger as it approached. This station could have kept our attention all day, but it was time to move on.

I realized that this system could save the Saturday morning cartoon from the slow death it was suffering. The familiar, unmoving characters and uninspired backgrounds that flood the airwaves could become a thing of the past. The early art and skill of such masters as the artists of Warner Brothers could be recaptured with the computer. The next station reinforced this belief.

Background

At the paint station, Paul Xander demonstrated a system that could have made Da Vinci drool. Mr. Xander paints background scenes for the studio, as well as fabulous foreground creations, and his ability is extraordinary. He put a scene on the screen, explaining that it could be viewed as six frames. In other words, a camera panning the scene would take in one sixth of the entire picture. Using an electronic tablet, he isolated one of the frames. A beautiful scene appeared, with details that couldn't be noticed in the original. With a flick of the pen attached to the electronic tablet, Mr. Xander began doing magic. He had a pallette of 256 colors, selected from a choice of several billion. With one command, any color could be changed wherever it occurred in the scene. Another command caused the colors to cycle through the pallette. In seconds, a day scene could be turned into a night scene.

"Brushes" can be selected or designed in software, with each brush producing a different stroke or design. Mr. Xander picked one and produced a stipple. "This has speeded my work by a factor of ten," he explained. "I never have to draw anything more than once." To prove the point, he drew a daisy. Then he defined the daisy as a temporary brush. Now, each touch of the pen would produce a flower. With one stroke of the pen on the tablet, he covered a hill with a line of daisies. Airbrushing could also be done with great ease. Another picture was pulled up, a seated imp in a green robe. After drawing dark lines on the imp's forehead, Mr. Xander switched to a software airbrush. In this mode, he feathered the line, blending the shadows. Next, he magnified the drawing; each pixel could be seen. This revealed the toning and shading produced by the virtual airbrush. He did an entire area of the drawing in the time a traditional artist would have used just to mix the paint.

Mr. Xander and Mr. Spielman are artists who have recently been introduced to the computer. While there is always a transition period, they both adapted to this new

These images were generated at the New York Institute of Technology's Computer Graphics Lab using many of Digital Equipment Corporation's computers. The spaceship was created by background artist Paul Xander, using the Paint system, an electronic pallette and brush with extraordinary capabilities. The Lifesavers are part of the Clio-winning commercial done with 3-D animation by Ephraim Cohen. Once the image has been generated, it can be rotated into any position and viewed from any camera angle. Photographs copyright 1981 by the New York Institute of Technology: all rights reserved.

technology. They both appreciate the ways computers can aid their work. In other words, they seem to enjoy what they are doing.

Filling the Gaps

The next stop was Ink and Paint. Here, Teri Doll and Sue Sparks fill in the drawings that come from Tween. They select from a pallette of fifteen colors, touching the color, then touching the area to fill. Only fifteen colors? Not really. When they redraw a line, it isn't drawn with a single color, but with fifteen shades, thus toning the line, producing a smooth transition between areas. They can also select a brush that touches up the background without disturbing the foreground.

A series of frames can be displayed in sequence, allowing them to be colored quickly. From here, the frames can be put on video tape, producing the finished animation. Any number of layers can be used. In traditional animation, there is a limit to the number of celluloid layers that can be used; as new layers are added, the background becomes darker. It must be lightened or the image won't be consistent. With computers, this problem doesn't exist.

Leaving Ink and Paint, we met Bruce Doll, who wrote many of the programs being used at the Computer Graphics Lab. Among his accomplishments, Mr. Doll has written a program that allows an operator to enter camera commands in English, thus speeding up another part of the animation process. There are many others who have contributed to NYIT's software, including Ed Catmull and Alvy Ray Singer, both of whom are now working for Lucasfilms, and Jim Blinn, who is currently doing simulated spacecraft movies for the Jet Propulsion Lab. NYIT's programs are written in C running under Unix.

This system could save the Saturday morning cartoon from the slow death it was suffering.

Perspective

So far, we had seen animation that was basically two-dimensional. Paul Rotstein showed us wonders of another kind, an Evans and Sutherland 3-D picture system. Seated before a screen showing a space ship, he moved a joystick. The ship traveled across the screen, rotated, moved into the distance and returned, maintaining true perspective throughout. The ship could be moved along any axis. Or the ship could remain stationary while the camera angle changed. What George Lucas does with models, NYIT does with numbers. Once the ship has been created, the artists can make it do anything they want. The power behind hardware that can do real-time three-dimensional animation is awesome.

As in the Tween station, frames could be produced through interpolation. Several locations could be specified; the computer would fill in the rest.

A Feast for the Eyes

After a lunch at the palatial de Seversky Conference Center, we were shown a videotape containing samples of NYIT animation. The tape opened with a jointed figure of the sort used in drawing classes. The figure was running in a circle. But the figure existed only in the mind of the computer. This was pure computer animation, done in this case by Jim Blinn. Other wonders were revealed; spinning logos, cartoons of Disney quality, a Lifesaver commercial that won a Clio award.

NYIT is working on a full-length movie, a space adventure referred to as "The Works." It should be finished in two years or so, and it will probably be one of the most astonishing things that will ever grace the screen. Thinking of films that had been

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nothing but special effects, I asked Louis Schure whether the movie would have a plot. He assured me that they realise the importance of a story. The movie wouldn't just be a showcase for special effects; it would be a complete film with plot, theme, and lots of glorious feasts for the eye.

Among their many developments, NYIT created a system that allows artists to draw scenes which can be immediately broadcast. This is the Paint system Paul Xander was using, the system that allowed him to rapidly create scenes while we watched. Sound familiar? Leroy Nieman used it during the winter Olympics. Ampex leased the system and has now released a similar unit, called AVA. Somewhere along the line, they forgot to give credit to NYIT.

NYIT also has fifty Apples. They've given some thought to exploring the area of educational software. If their present work is any indication, they could come up with some excellent results.

Before we left, Bruce Laskin, Director of NYIT's Digital Research Lab, showed us the new VK100 terminal from DEC. Mr. Laskin, who was with us for a good part of the tour, seemed to be involved in most of the lab's projects, and showed us the features of many devices, from videotape machines to CRT's. He also took us to a studio where Jane Kennedy was being filmed for a spot on Home Box Office. This area, he explained, had been selected by the producers of *Three Days of the Condor* when they needed to film a computer room. These producers had walked by the PDP's, the graphic machines, and rooms full of real computers and hard disk drives, and had not found what they were looking for. Finally, on seeing the spinning tape reels of the video lab, they knew they had found their computer room. No comment.

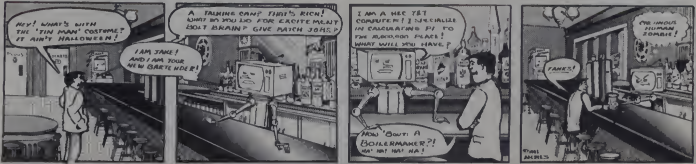
NYIT is working on a full-length movie, a space adventure referred to as "The Works."

Scene from "The Works," an animated science-fiction film produced with the aid of computer graphics.

The next time you see an unbelievable animation segment on television, there is a good chance it was created at NYIT. I'd like to thank Louis Schure and everyone else who guided our tour through this wonderful lab. That about covers this day of marvels. But one question remains. When they hand out the Academy Award for the best picture of 1982, will a computer in black tie be sitting at one of the tables? □

Popular Computing

Chas Andres



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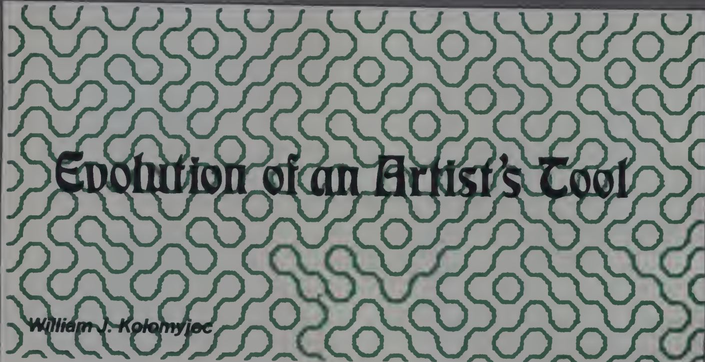
Evolution of an Artist's Tool

William J. Kolomyjec



Amoeba

For years, computer artists have been using large computers with expensive peripheral devices as a medium for the formulation of computer imagery. In the beginning, it was a matter of keypunching and submitting a program "batch" mode then waiting two to twenty-four hours, perhaps only to find that an error meant the whole process had to be repeated. John Whitney Sr. made the analogy in his film "Experiments in Motion Graphics" of playing a piece of music on a piano and then having to wait several hours to hear the resultant sounds. Assuming then that he could tolerate the poor turnaround time, all a person needed to do computer graphics was to be in the proximity of, and have access to, a large computer system with the appropriate graphic peripheral devices!

All artists must be aware of the elements of their medium. One does not attain status as a painter without knowledge and proficiency with a paint brush. Similarly, one cannot claim to be a computer graphic artist without the knowledge and proficiency with the graphic device. The rub, as it were, is comparing a paint brush with a graphic peripheral device. In the traditional media (painting, printmaking, etc.) we find: the inspiration (the mind), the technique (the craft or hand) and the final image (the statement). Computer aesthetic imagery has been called a somewhat lesser art form because the hand is removed from the process. This is, of course, absurd. The delivery mode of the computer artist, if anything, expands this concept of mind-hand-statement to include the knowledge and use of technology. Somewhere between the mind and the hand must be understanding of how to write a program to produce a desired image.

Rape of the Grape

It is gratifying to know that in the last ten years advances in technology and consumerism have made the personal computer a reality. In addition to affordable microprocessors, we are beginning to see affordable graphic peripheral devices. With these components, it is now possible to put together a reasonable quality computer graphic system. What this means to the would-be computer artist is that he can afford to have his own computer system with graphic capabilities in the studio. Not only does this solve the availability and access problem, but it also puts the tool back into the hand of the artist in his own environment.

By way of example I submit the imagery accompanying this article as proof that such systems can produce quality aesthetic imagery. These illustrations were produced on the following system: Apple II with 48K RAM, disk drive, TV monitor, serial I/O peripheral card and Houston Instruments X-Y digital plotter. This whole system can be purchased for less than $3,500. There are, to be sure, disadvantages to such a system: the capabilities of the processor are limited, i.e., it is rather slow compared to a "large machine"; program space is limited; and the plotter has a small bed and produces a rather coarse line (0.005 step size). However, the advantages abound: it is all hands-on, it is convenient, programs can

Bill Kolomyjec, College of Engineering, Michigan State University, East Lansing, MI 48824.

be proofed on the CRT before plotting, programs can be easily edited, and any paper, including fine art papers, can be used with the plotter.

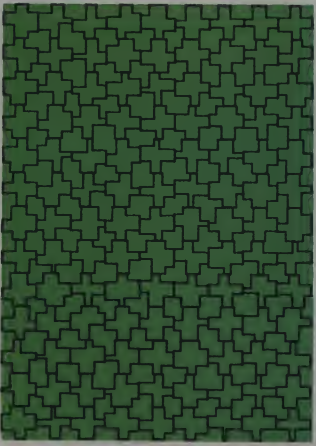
Perhaps the most significant point is that thanks to the recent evolution of computers and graphic peripherals, more people will begin to make use of this delivery mode as a form of individual expression. Microprocessor graphic systems are within reach of those who desire to explore the realm of computer image generation. Certainly, the cost barrier has been breached. Similarly, the software provided with this equipment, in most cases, incorporates the rudiments for generating graphic imagery. Now we can begin to turn more of our efforts toward the larger concerns of aesthetics and the technique of aesthetic image generation via graphic algorithms.

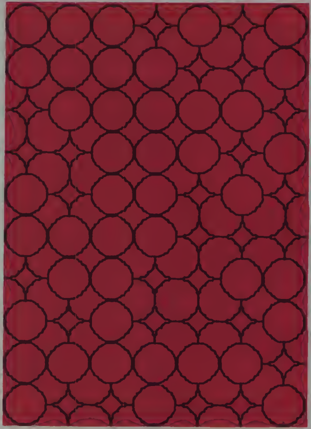
Artist's Notes

Amoeba, Chopped Square Tessilation, and Circle Layers are all examples of plotting an array of a single module, variations thereof or visually similar modules. All three use randomness in the following ways:

1. Amoeba: The microcomputer simulates a coin flip to pick one of two variations.

Chopped Square Tessilation





Circle Layers

123 if RND (1) - 0.5 < 0 then go one way
124 go the other

In this case the modules consist of quarter circles, in the upper left and lower right or upper right lower left, which fit into a square such that these quarter circles start and stop at the midpoints of their respective sides.

2. Chopped Square Tessilation: This image is basically an array of squares which get their corners nibbled way by having the microcomputer randomly take some length—less than half—off the sides.

3. Circle Layers: The micromputer uses the coin flip to pick either a circular module or curvilinear four-pointed star. The trick here is not so much the randomness as the way these two modules are designed to complement each other.

Rape of the Grape is a premeditated attempt at generating a representational image that shows the real aesthetic potential of the medium. (One of the major criticisms of computer art is that the majority of it looks like it was done by some engineer or scientist. In reality this argument has merit.) The majority of the image is digitized, but several algorithmic processes are employed. The hair is formed by linear interpolation between the upper and lower curves. The grapes are formed by arcs and circles *a la* an arc subroutine. The aura by a dashed line variation of the arc subroutine. □

FOR TRS-80*

SUPERSCRIPT

By Richard Wilkes

Now you can easily print
BOLDFACE, underlined text,
slashed Ø's, special characters,
superscripts & subscripts (A^C X $\log_e[A_1-A_n]$) and more!

With this enhancement to Radio Shack's Model I Scripsit,* you will turn a good word processing system into a great one. SuperScript adds many of the features that Fort Worth left out, including:

Custom print drivers for:
Diablo (serial or parallel)
NEC Spinwriter (serial or parallel)
RS Line Printer IV*/Centronics 737
RS Daisy II*
Standard serial and parallel printers
User-defined custom drivers (serial or parallel)

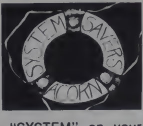
You can call up the disk directory or kill files without leaving Scripsit—and without losing your text! Pause the printout to insert text from your keyboard or change type wheels, then resume printing where you left off.

Using any printer with backspace capability, you can underline text and produce computer-type slashed zeros. And on Diablo, Daisy II and NEC printers, you can superscript, subscript, underline, print boldface and select 10- or 12-pitch. With the Line Printer IV/737, you can underline, print elongated boldface, select 10 or 16.5 pitch, and use proportional spacing (unjustified).

The keyboard driver is now modified to correct for repeating key hangups. You may specify spacing requirements to eliminate awkward spacing of critical text. And, with SuperScript, you can now enter special characters (brackets, braces, etc.) that are not found on the TRS-80* keyboard.

All these capabilities, and more, are available when you add SuperScript to your Model I Scripsit program. Available for just $29.95 on disk, including easy instructions for patching to Scripsit and an enhanced lowercase driver.

SYSTEM SAVERS



By Tom Stibolt

If you ever type "SYSTEM" on your TRS-80,* this two-program package will make life easier for you.

One of the programs, FLEXL, lets you make backup copies of any system format tape. Using your own recorder usually means easier loading than with machine-duplicated original tapes, and you will be able to store your original safely away. Copies made using FLEXL display the filename of each program as it loads, making file searches easier.

Disk drive owners can use TDISK to save any system format tape onto disk. "Editor/Assembler", "Air Raid" and other programs cannot normally be loaded to disk, but with TDISK, they can. It will even load non-contiguous tapes. Why put up with slow tape loading? TDISK files will load from disk in seconds.

Get this two-program package now for only $14.95. Just one of Acorn's fine utility programs.

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DEALER INQUIRIES INVITED

CIRCLE 101 ON READER SERVICE CARD

Profile of a Legend

Leo Christopherson

Photo by Andy Jacobson.

The bee flits precariously above the tarantula, his little wings buzzing, waiting for a chance to deliver a points-winning sting. The tarantula sees this flying yummy and leaps into the air, trying to make him dinner. Who will win, the spider or the bee?

The number one android looks at the number to his right, then at the droids to his left. He approves the number, nodding, then points his laser pistol and dispatches the right number of droids to continue the game.

The demon does the softshoe to the strains of "Swanee River" and pertly bows at the end of his routine. He does his dance flawlessly, to the delight of all who watch.

Andy Android's brother Harvey, Lasersaber in hand, steps out to begin the tournament to the Celeste Sound version of "March of the Gladiators." As he battles for supremacy, the child who moved him through six practice fights watches breathlessly, rooting for this brave and tireless droid.

The droids, the bee, the spider, the demon, and those wacky, weird characters from Life Two seem alive. They have an amazing amount of vitality and personality. They move smoothly, and with a grace that belies their residence in a block graphic computer such as the TRS-80. They are the products of genius, talent and sensitivity. They are the children of Leo B. Christopherson.

Bob Liddil, The Programmer's Guild, Box 66, Peterborough, NH 03458.

The Demon does the softshoe to the strains of Swanee River.

Leo is a math and science teacher for Keithly Junior High School in Tacoma, WA. He also leads a Title I modified math class which uses Radio Shack's K-8 Math Practice program to good advantage.

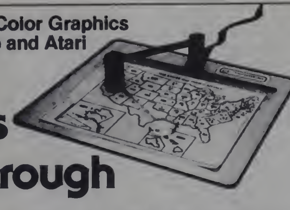
After school, at least four days of the week he tries to stay for the Computer Club. Called the Tabari Society, they have both closed meetings and a "game night," and so are able to meet the needs of most students wishing to participate. On game nights an admission fee of 25 cents is charged. The money is used to purchase computer related materials for the club.

Observers have noted that the young people in Leo's classes are "crazy about him." His quiet, intelligent approach to teaching serves as an inspiration to those with whom he comes in contact. He is organized and creative in his teaching, and these same traits are evident in the environment he creates for himself at home.

Leo is an accomplished musician. In his youth he played professionally in a band. Now, however, he contents himself with composing and executing ethnic specialty music on the organ and his Apple computer, which contains the most advanced hardware available for musical rendition. His organ and the amplification equipment that it employs, occupy most of his apartment.

Android Nim created a sensation in the commercial TRS-80 software market. Where most TRS-80 graphics programs

High-Resolution Color Graphics for the Apple and Atari



Graphics Breakthrough

How many programs have you written that would benefit from animated high-resolution graphics? Probably several. It is this kind of dramatic graphics that distinguish outstanding programs from ordinary ones. But if you've ever agonized for hours or days just to get one image perfected, you're probably not anxious to do it again. Now there's a better way.

New Graphics Entry System

Today there is a new graphics system available that is not only amazingly user-oriented but surprisingly economical. Called VersaWriter, it starts with an ingeniously simple entry board consisting of a 14" X 12" high impact plastic bed with a tough clear plastic overlay sheet. The original drawing or diagram is fastened with masking tape to the plastic bed and then covered with the clear sheet. Instead of using a light pen or complicated electronic X-Y head, the VersaWriter uses a double jointed arm attached to the top of the entry board at one end and a magnifying lens with crosshairs at the other end. The VersaWriter resembles a draftsman's pantograph on a smaller scale.

At each joint in the arm of the VersaWriter is a potentiometer. A cable from these pontentiometers connects to the paddle input of the computer. No special interface electronics or board is needed. Since the arm of the VersaWriter bends only in one direction, each point on the plotting head corresponds to a unique set of resistances on the potentiometers. All that's needed now is software to translate these resistances into usable screen coordinates.

Exceptionally powerful software

It is in the software where VersaWriter really stands out. VersaWriter comes with two full disks of user-oriented software. First it has sets of "low level" commands for entering, creating and copying drawings and diagrams. Secondly, it has extensive sets of application routines for moving, enlarging, rotating, coloring or animating drawings that the user has created.

Graphics Systems

Versa Writer	**$249.00**
Kurta Graphics Tablet	**695.00**
Summagraphics Digitizer	**745.00**
Houston Instruments Hi Pad	**795.00**
Apple Graphics Tablet	**795.00**

Of course the basic commands let you enter a drawing freehand or by tracing it. Want a wider "brush stroke"? Six widths are available. Drawings can be independently scaled in both the vertical and horizontal directions. An enclosed shape may be filled in with any of 212 colors. No, that is not a misprint—by the same technique that a printing press can create hundreds of colors from three primary ones, so can VeraWriter.

Here a shape (the letter A) is being scanned. After putting it in a shape table it may be used in other programs.

From the shape table, a shape (the letter A) may be enlarged, shrunk, rotated, colored or moved about the screen.

Create Animation for Other Programs

The shapes you create with VersaWriter can be used and manipulated with ease in other programs. Up to 255 shapes can be entered into a shape table. These shapes may then be placed on the screen in any position or may be overlaid on a full or partial screen image. Animation is produced easily by moving about a portion of the image created by VersaWriter. For example, by alternating between two images of an airplane propeller it will appear to be spinning.

Other VersaWriter software includes text-writer with which text can be added to graphics. Upper and lower case, choice of color, text size, direction and starting point all may be specified.

The Area/Distance program lets you calculate distances (or perimeters) by entering a scale and tracing a shape or map route with the drawing arm. Areas of figures, open and irregular, can be similarly calculated.

The software also includes sets of electronic and computer logic shapes. In addition, an entire disk of dramatic demonstration graphics is included. These twelve full-screen graphics run the gamut from a fully labeled cross section of a human skull to colored maps to animated cartoons to an electronics schematic.

Free Software Updates

You may have read a review of VersaWriter that indicated that the color fill routine was slow. It was. But not anymore. Several new routines and improvements were added to the VersaWriter software since its introduction. All customers of Peripherals Plus received these changes free.

As new updates are developed, Peripherals Plus will furnish them free to all customers FOREVER. We make this unique guarantee because it is in our best interest to have you make the best use of your computer. We're convinced that if other people see your VersaWriter in use, they'll want one too.

Best Performance and Price

At Peripherals Plus, we evaluated every graphics entry device. We wanted to handle the best one regardless of price. VersaWriter has the best performance bar none. Surprisingly it also has the lowest price, just $249.00 for the Apple version.

VersaWriter requires an Apple II with Applesoft in ROM (or an Apple II Plus), disk, and 48K of memory. The Atari version requires an Atari 800, disk and at least 32K. It is priced at $300.

VersaWriter comes complete with two disks of software, a comprehensive instruction manual, a 90-day limited warranty and Peripherals Plus unique guarantee of software updates forever.

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CIRCLE 239 ON READER SERVICE CARD

were slow and herky-jerky. Nim was animated, and alive, with little eyes that stared ubiquitously, emotionally out from cloned Andys awaiting the executioner's laserbeam. Leo had brought the fine art of humoresque cartooning to the TRS-80.

Snake Eggs was next. It uses animated rattlesnakes, modelled after those in a Disney production of "Robin Hood," to illustrate the traditional game of "21." This program was also one of the first to incorporate sound effects, a technology that was in its infancy, and was, to a great extent, pioneered by Leo himself.

One of the most beloved of Leo's TRS-80 graphics presentations and without question the one most revealing of his subtle sense of humor, is Bee Wary. The Tarantula, the heavy in this slapstick micro-melodrama, has many faces and a wry vocabulary that leaves its audiences in pain from laughter. The Bee, controlled by the user, is much more mobile, and can deliver a deadly sting. But its opponent has several unexpected moves that can turn the bee into a hearty meal.

Life Two introduced a trio of new characters. A quadreped, a triped and a monoped, plus Andy representing bipeds added a new twist to the Game of Life. Billed as the Battle of Life, this presentation may be the most articulate portrayal of Life ever conceived.

Dancin' Demon used an extension of a graphics innovation technique called "line packing" as opposed to the "string packing" that characterized Leo's earlier efforts.

"These ideas have never been completely thought out in my mind before I start them," says Leo. "Rather, one completed part often suggests another new idea to try in the same program. I have yet to think of a concept to program without also coming up with a new technique, which often modifies the original idea of the program."

As a display, Demon does a fine job. But it is not enough to just have great graphics. The program must be interactive. And it is. The user can use an onboard music generator to program his own musical score. Thus, the actions of the Demon become more personalized. An added bonus is in the programmability of the dance steps. The user has a choice of endless combinations of dance routines. Through these features, the non-programmer joins Leo in the often hilarious musical productions of Dancin' Demon.

Radio Shack, which is not well known for making fast decisions on submissions, acted very quickly upon receiving Dancin' Demons. In short order, Leo joined that elite fraternity of programmers whose works are mass marketed around the world.

"My newest program, Duel-n-Droids" says Leo, "uses the new graphics technique that I started for Demon but couldn't use due to memory space problems. The technique involves placing the droids on the screen so fast that one overlaps the other, creating the illusion of shading. The androids appear to be wearing uniforms and the display is rather alive."

"Droids also employs a technique I've wanted to try for some time. The player can 'teach' his android to fight before entering the tournament. I also found a place to try out some new sound and musical effects."

The musical effects Leo speaks of are a series of songs using the TRS-80 cassette port to produce a "Celeste" tone with vibrato that rivals music accessory boards.

Two new programs by Leo are in prerelease, at this writing. Snake Eggs II for the Apple is a mathematics drill application of the earlier game. Featuring the hi-res graphics available to Apple users, and the sound built into the computer, the

Leo's reaction to those who would imitate his graphics style is one of encouragement.

result is a highly rewarding and potentially very popular program. Also, by popular request, our old friend Andy makes an Apple appearance in Apple Andy, to be known commercially as Apple Android Nim. It, too, stretches the Apple computer to its limits.

Sadly, at least from a commercial point of view, the new programs are destined for the same intense bootlegging that has plagued the TRS-80 releases. How does Leo feel about the bootleggers?

"I am concerned about the moral implications of software piracy," Leo comments sadly. "Most bootleggers aren't hard core pirates at all but family people with little children who use the computer daily. These children see the parent get something for nothing, and they quickly form similiar attitudes. The software traders and pirates set a very poor example for their kids."

There has developed, over the last couple of years, a public fascination with Leo's work, prompting talented young programmers to steer away from clever and highly animated techniques for fear of infringing on what has become known as "Christopherson Graphics."

Leo's reaction to those who would imitate his graphics style is one of encouragement. His attitude is "go for it." He believes that the animation style of programming belongs to anyone who is able to produce it. His own techniques are easily available to those who would use or improve them.

When asked what advice he has for new programmers who would like to be commercially successful, Leo mentioned six main points:

"Get to know your machine. The manufacturer usually publishes only a fraction of the routines available in your computer's particular language or chip machine code.

"When you do your program, write for *your* machine. Don't generalize in hopes of easy translation. Maximize your techniques to draw every last bit of power your machine is able to muster. Only then will you have your best program.

"Let ideas flow creatively. Build an atmosphere conducive to free thinking. Relax and allow your mind to work. Never throw out an idea; store it for a future application.

"Know the limitations of your machine. Never juryrig a routine or place your techniques in a position where failure of logic is possible.

"Expect months of hard work. Nothing comes easily, least of all production of commercial software. Short cuts and less than exhaustive debugging will cost you far more than the time you save. Be thorough.

"Never let inferior work leave your sight. You travel with each reproduction of your software, into thousands of computers. Never let less than perfect copies of your program get away from your control.

"Do not manufacture or attempt to sell your programs on your own unless you are prepared for heavy expense and disappointment or possibly even the loss of your work to unscrupulous companies. Find, instead, an agent or software company of high reputation that can either place your product or market it for you. These individuals or corporations have the knowhow to produce or place your program where it will make the most profit for you. But beware of grandiose promises. Check up on them before releasing anything."

Who is Leo B. Christopherson? He is Andy and The Spider, and a little bit of the Demon, for they are his creations and he travels with them. But most of all he is a gentle, quiet schooleacher from Tacoma, WA, who loves his kids as much as they love him. He is happy and spreads that happiness around. Who could ask for more. □

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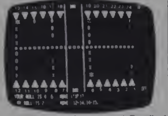

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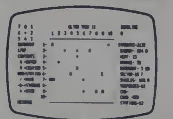

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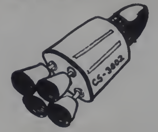

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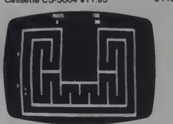

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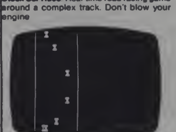

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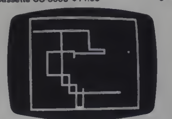

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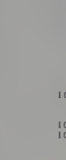
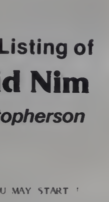
CIRCLE 300 ON READER SERVICE CARD

Complete Listing of
Android Nim

Leo Christopherson

```
  1 REM  * COPYRIGHT 1978 80-NW PUBLISHING TACOMA, WA
      *
  2 REM  * ALL RIGHTS RESERVED *
  3 CLS :
     PRINT @20,"N O T I C E"
  4 PRINT :
     PRINT "IT IS ILLEGAL, UNFAIR & UNCOUTH TO COPY TH
     IS PGM FOR SOME"
  5 PRINT "ONE ELSE. IT CHEATS THE AUTHOR OF ROYALTIE
     S AND REMOVES ANY"
  6 PRINT "INCENTIVE TO PRODUCE MORE GOOD WORKS - THA
     NKS"
  8 INPUT "PUSH ENTER";
  9 CLS :
     RUN 10020
 10 CLEAR 525:
     DEFINT X,Y,Z:
     RANDOM
 25 GOTO 900
 50 MD$ = "RIDICULOUS":
     RETURN
 51 MD$ = "ABSURD":
     RETURN
 52 MD$ = "GROTESQUE":
     RETURN
 53 MD$ = "NONSENSICAL":
     RETURN
 54 MD$ = "FARCICAL":
     RETURN
 55 MD$ = "PREPOSTEROUS":
     RETURN
 56 MD$ = "SILLY":
     RETURN
 57 MD$ = "SENSELESS":
     RETURN
 58 MD$ = "IRRATIONAL":
     RETURN
 59 MD$ = "FANTASTIC":
     RETURN
 60 MD$ = "ODD":
     RETURN
 61 MD$ = "RUDE":
     RETURN
 62 MD$ = "BRUTISH":
     RETURN
 63 MD$ = "BARBARIC":
     RETURN
 64 MD$ = "PLEBEIAN":
     RETURN
 65 MD$ = "UNCIVIL":
     RETURN
 66 MD$ = "DISCOURTEOUS":
     RETURN
 67 MD$ = "VULGAR":
     RETURN
 68 MD$ = "COARSE":
     RETURN
 69 MD$ = "GROSS":
     RETURN
 70 MD$ = "UNGRACEFUL":
     RETURN
 71 MD$ = "MONSTROUS":
     RETURN
 72 MD$ = "HORRID":
     RETURN
 73 MD$ = "SHOCKING":
     RETURN
 74 MD$ = "CHEAP":
     RETURN
900 GOSUB 9000
1000 X9 = 1:
     CLS :
     PRINT @25, CHR$(34);"ANDROID NIM"; CHR$(34);
1005 X = 194:
     GOSUB 8000:
     PRINT @X,BQ$;
1010 X = 517:
     GOSUB 8000:
     PRINT @X,BQ$;
1011 X = 835:
     GOSUB 8000:
     PRINT @X,BQ$;
1012 Y9 = 1:
     RW$(1) = "0":
     RW$(2) = "0":
     RW$(3) = "0"
1013 GOSUB 1040:
     GOTO 1050
1016 X = 254:
     FOR N = 1 TO 7:
      X = X - 7:
      GOSUB 8000:
      NEXT N:
     X = 570:
     FOR N = 1 TO 5:
      X = X - 8:
      GOSUB 8000:
      NEXT N:
     X = 885:
     FOR N = 1 TO 3:
      X = X - 9:
      GOSUB 8000:
      NEXT N
1017 RW$(1) = "7":
     RW$(2) = "5":
     RW$(3) = "3"
1018 GOTO 8200
1040 FOR N = 77 TO 333 STEP 64:
      PRINT @N, CHR$(30);:
      NEXT N:
     FOR N = 402 TO 658 STEP 64:
      PRINT @N, CHR$(30);:
      NEXT N:
     FOR N = 730 TO 986 STEP 64:
      PRINT @N, CHR$(30);:
      NEXT N:
     PRINT @22," ";:
     RETURN
1050 PRINT @540,"FIRST MOVE BY YOU (1) OR ME (2) ?";
1054 GOTO 1060
1055 X = 194:
     GOSUB 8005:
     X = 517:
     GOSUB 8005:
     X = 835:
     GOSUB 8005:
     RETURN
1060 GOSUB 8070:
     K$ = INKEY$:
     IF K$ = ""
      THEN
       1060:
      ELSE
       IF K$ = "1"
        THEN
         1110:
        ELSE
         IF K$ = "2"
          THEN
           1075:
          ELSE
           IF K$ = "Y"
            THEN
             1064:
            ELSE
             IF K$ = "M"
              THEN
               1099:
              ELSE
               1060
1064 GOTO 1065
1065 E$ = INKEY$:
     IF E$ = ""
      THEN
       1065:
      ELSE
       1069
1069 GOSUB 1055
1070 Y$ = INKEY$:
     IF Y$ = ""
      THEN
       1070:
      ELSE
       K$ = K$ + E$ + Y$:
       IF K$ = "YOU"
        THEN
         1075:
        ELSE
         1500
1075 X9 = 2:
     PRINT @540,"OK, I'LL START !                ";:
     FOR O = 1 TO 12:
      GOSUB 8070:
      NEXT O:
     PRINT @540,"                                ";:
     GOTO 1016
1099 GOSUB 1055
1100 E$ = INKEY$:
     IF E$ = ""
      THEN
       1100:
      ELSE
       K$ = K$ + E$:
       IF K$ = "ME"
        THEN
         1110:
        ELSE
         1500
1110 X9 = 1:
     PRINT @540," VERY WELL , YOU MAY START !        ";:
     X = 517:
     GOSUB 8010:
     X = 835:
     GOSUB 8010:
     X = 194:
     GOSUB 8010:
     FOR M = 1 TO 12:
      GOSUB 8070:
      NEXT M:
     PRINT @540,"                                    ";:
     GOTO 1016
1500 PRINT @540,"WHICH ONE OF US IS , "; CHR$(34);K$;
     CHR$(34);" ?       ";:
     X = 835:
     GOSUB 8010:
     X = 194:
     GOSUB 8010:
     X = 517:
     GOSUB 8010:
     GOSUB 8112:
     GOTO 1050
7000 PRINT @22," ";
7005 ON Y9 GOTO 7020,7010,7010
7006 GOTO 7200
7010 M = RND(2):
     ON M GOTO 7020,7200
7020 FOR O = 1 TO 12:
      GOSUB 8070:
      NEXT O:
     GOTO 7275
7200 Z = 1:
     GOSUB 7500:
     Z1 = Z0:
     Z = 2:
     GOSUB 7500:
     Z2 = Z0:
     Z = 3:
     GOSUB 7500:
     Z3 = Z0
```





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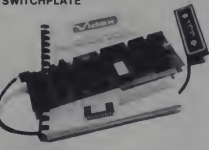
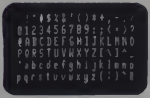
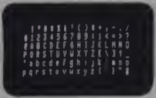




7X12 MATRIX
18X80 OPTIONAL



7X9 MATRIX
24X80 STANDARD

VIDEOTERM

BASICs — VIDEOTERM lists BASIC programs, both Integer and Applesoft, using the entire 80 columns Without splitting keywords Full editing capabilities are offered using the ESCape key sequences for cursor movement With provision for stop/start text scrolling utilizing the standard Control-S entry And simultaneous on-screen display of text being printed

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Other Boards — The new Microsoft Softcard* is supported So is the popular D C Hayes Micromodem II*, utilizing customized PROM firmware available from VIDEX The powerful EasyWriter* Professional Word Processing System and other word processors are now compatible with VIDEOTERM Or use the Mountain Hardware ROMWriter* (or other PROM programmer) to generate your own custom character sets Naturally, VIDEOTERM conforms to all Apple OEM guidelines, assurance that you will have no conflicts with current or future Apple II* expansion boards

Advanced Hardware Design — VIDEOTERM's on-board asynchronous crystal clock ensures flicker-free character display Only the size of the Pascal Language card, VIDEOTERM utilizes CMOS and low power consumption ICs, ensuring cool, reliable operation All ICs are fully socketed for easy maintenance Add to that 2K of on-board RAM, 50 or 60 Hz operation, and provision of power and input connectors for a light pen Problems are designed out, not in

Available Options — The entire display may be altered to inverse video, displaying black characters on a white field PROMs containing alternate character sets and graphic symbols are available from Videx A switchplate option allows you to use the same video monitor for either the VIDEOTERM or the standard Apple II* display, instantly changing displays by flipping a single toggle switch The switchplate assembly inserts into one of the rear cut-outs in the Apple II* case so that the toggle switch is readily accessible And the Videx KEYBOARD ENHANCER can be installed, allowing upper and lower case character entry directly from your Apple II* keyboard

Firmware — 1K of on-board ROM firmware controls all operation of the VIDEOTERM No machine language patches are needed for normal VIDEOTERM use

Firmware Version 2.0

Characters	7 x 9 matrix	Display	24 x 80 (full descenders)
Options	7 x 12 matrix option, Alternate user definable character set option, Inverse video option		18 x 80 (7 x 12 matrix with full descenders)

Want to know more? Contact your local Apple dealer today for a demonstration VIDEOTERM is available through your local dealer or direct from Videx in Corvallis, Oregon Or send for the VIDEOTERM Owners Reference Manual and deduct the amount if you decide to purchase Upgrade your Apple II* to full terminal capabilities for half the cost of a terminal VIDEOTERM At last

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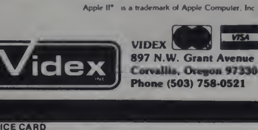

PRICE
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Corvallis, Oregon 97330
Phone (503) 758-0521

CIRCLE 240 ON READER SERVICE CARD

Android Nim, continued...

```
7210 Z4 = Z1 + Z2:
     Z5 = Z1 + Z3:
     Z6 = Z2 + Z3:
     Z4$ = STR$(Z4):
     Z5$ = STR$(Z5):
     Z6$ = STR$(Z6)
7220 GOSUB 8070:
     IF Z4 = 0
      THEN
       7230:
      ELSE
       Z0 = LEN(Z4$):
       Y0 = 1:
       Z4 = 0:
       FOR N = Z0 TO 1 STEP - 1
7222  IF MID$(Z4$,N,1) = "1"
       THEN
        Z4 = Z4 + Y0
7223  Y0 = Y0 * 2:
      NEXT N
7230 GOSUB 8070:
     IF Z5 = 0
      THEN
       7240:
      ELSE
       Z0 = LEN(Z5$):
       Y0 = 1:
       Z5 = 0:
       FOR N = Z0 TO 1 STEP - 1
7232  IF MID$(Z5$,N,1) = "1"
       THEN
        Z5 = Z5 + Y0
7233  Y0 = Y0 * 2:
      NEXT N
7240 GOSUB 8070:
     IF Z6 = 0
      THEN
       7250:
      ELSE
       Z0 = LEN(Z6$):
       Y0 = 1:
       Z6 = 0:
       FOR N = Z0 TO 1 STEP - 1
7242  IF MID$(Z6$,N,1) = "1"
       THEN
        Z6 = Z6 + Y0
7243  Y0 = Y0 * 2:
      NEXT N
7245 GOSUB 8070
7250 IF VAL(RW$(3)) < = Z4
      THEN
       7255
7251 RW = 3:
     GOSUB 8430:
     RN = VAL(RW$(3)) - Z4:
     RN$ = STR$(RN):
     RN$ = RIGHT$(RN$,1):
     X9 = 1:
     GOTO 8240
7255 IF VAL(RW$(2)) < = Z5
      THEN
       7260
7256 RW = 2:
     GOSUB 8420:
     RN = VAL(RW$(2)) - Z5:
     RN$ = STR$(RN):
     RN$ = RIGHT$(RN$,1):
     X9 = 1:
     GOTO 8240
7260 IF VAL(RW$(1)) < = Z6
      THEN
       7270
7261 RW = 1:
     GOSUB 8410:
     RN = VAL(RW$(1)) - Z6:
     RN$ = STR$(RN):
     RN$ = RIGHT$(RN$,1):
     X9 = 1:
     GOTO 8240
7270 GOSUB 8070:
     X8 = 0:
     IF (Z4 = 0) AND (Z5 = 0)
      THEN
       7300
7275 M = RND(3)
7276 ON M GOTO 7277,7278,7279
7277 IF VAL(RW$(1)) = 0
      THEN
       7278:
      ELSE
       RW = 1:
       GOSUB 7290:
       GOSUB 8410:
       X9 = 1:
       X8 = 0:
       GOTO 8240
7278 IF VAL(RW$(2)) = 0
      THEN
       7279:
      ELSE
       RW = 2:
       GOSUB 7290:
       GOSUB 8420:
       X9 = 1:
       X8 = 0:
       GOTO 8240
7279 IF VAL(RW$(3)) = 0
      THEN
       7277:
      ELSE
       RW = 3:
       GOSUB 7290:
       GOSUB 8430:
       X9 = 1:
       X8 = 0:
       GOTO 8240
7290 M = RND(7):
   ON M GOTO 7291,7292,7293,7294,7295,7296,7297
7291 RN = 1:
     RN$ = "1":
     RETURN
7292 GOTO 7291
7293 GOTO 7291
7294 GOTO 7291
7295 RN = 2:
     RN$ = "2":
     RETURN
7296 RN = 3:
     RN$ = "3":
     RETURN
7297 IF RW=3
      THEN
       7295
      ELSE
       RN = 4 :
       RN$ = "4" :
      RETURN
7300 GOTO 7350
7350 GOSUB 1040
7360 IF X9 = 1
      THEN
       7400
7370 GOSUB 7600:
     GOSUB 8070:
     X = 194:
     GOSUB 8035:
     GOSUB 8114:
     X = 835:
     GOSUB 8035:
     GOSUB 8116:
     X = 517:
     GOSUB 8035:
     GOSUB 8114:
     PRINT @453,H5$;:
     GOSUB 8116:
     PRINT @771,H5$;:
     GOSUB 8116:
     PRINT @130,H5$;:
     GOSUB 8114:
     PRINT @130,HR$;
7375 GOSUB 8114:
     PRINT @771,HR$;:
     GOSUB 8116:
     PRINT @453,HR$;:
     GOSUB 8114:
     GOTO 7420
7400 GOSUB 1055:
     PRINT @536,MB$;:
     PRINT @472,MA$;:
     PRINT @600,MC$;:
     GOSUB 8112:
     GOSUB 8112:
     GOTO 7420
7420 PRINT @794,"NEW GAME?   YES (1) OR NO (2)";
7425 GOSUB 8070:
     K$ = INKEY$:
     IF K$ = ""
      THEN
       7425:
      ELSE
       IF K$ = "1"
        THEN
         1012:
        ELSE
         7430
7430 CLS :
     GOTO 3
7450 GOSUB 1040:
     RW$(1) = "0":
     RW$(2) = "0":
     RW$(3) = "0":
     PRINT @540,"SINCE YOU HAVE GIVEN UP ... ";:
     FOR O = 1 TO 8:
      GOSUB 8070:
      NEXT O:
     GOSUB 1040:
     GOTO 7400
7500 ON VAL(RW$(Z)) + 1 GOTO 7505,7510,7515,7520,7525,
     7530,7535,7540
7505 Z0 = 0:
     RETURN
7510 Z0 = 1:
     RETURN
7515 Z0 = 10:
     RETURN
7520 Z0 = 11:
     RETURN
7525 Z0 = 100:
     RETURN
7530 Z0 = 101:
     RETURN
7535 Z0 = 110:
     RETURN
7540 Z0 = 111:
     RETURN
7600 GOSUB 7700:
     W1$ = MD$
7601 GOSUB 7700:
     IF MD$ = W1$
      THEN
       7601:
      ELSE
       W2$ = MD$
7602 GOSUB 7700:
     IF (MD$ = W1$) OR (MD$ = W2$)
      THEN
       7602:
      ELSE
       W3$ = MD$
7603 GOSUB 7700:
     IF (MD$ = W1$) OR (MD$ = W2$) OR (MD$ = W3$)
      THEN
       7603:
      ELSE
       W4$ = MD$
7604 GOSUB 7700:
     IF (MD$ = W1$) OR (MD$ = W2$) OR (MD$ = W3$)
     OR (MD$ = W4$)
      THEN
       7604:
      ELSE
       W5$ = MD$
7605 GOSUB 7700:
     IF (MD$ = W1$) OR (MD$ = W2$) OR (MD$ = W3$)
     OR (MD$ = W4$) OR (MD$ = W5$)
      THEN
       7605:
      ELSE
       W6$ = MD$
7606 GOSUB 7700:
     IF (MD$ = W1$) OR (MD$ = W2$) OR (MD$ = W3$)
     OR (MD$ = W4$) OR (MD$ = W5$) OR (MD$ = W6$)
      THEN
       7606:
      ELSE
       W7$ = MD$
```

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VISA

Android Nim, continued...

```
7610 PRINT @412,"THROUGH SOME ";W1$ + ",";:
     GOSUB 8118:
     PRINT @470,W2$ + ",";:
     GOSUB 8118:
     PRINT @470,W2$ + "," + W3$ + ",";:
     GOSUB 8118:
     PRINT @470,W2$ + "," + W3$ + "," + W4$ + ",";:
     GOSUB 8118
7620 PRINT @534,W5$ + ",";:
     GOSUB 8070:
     PRINT @534,W5$ + "," + W6$ + ",";:
     GOSUB 8070:
     PRINT @534,W5$ + "," + W6$ + "," + W7$ + ",";:
     GOSUB 8070
7630 PRINT @610,"STROKE OF FATE...";:
     GOSUB 8118:
     PRINT @678,"YOU WIN !";
7640 RETURN
7700 M = RND(25)
7705 ON M GOSUB 50,51,52,53,54,55,56,57,58,59,60,61,62
     ,63,64,65,66,67,68,69,70,71,72,73,74
7710 RETURN
7951 IF VAL(RW$(1)) < 7
      THEN
       7952:
      ELSE
       X = 205:
       RETURN
7952 IF VAL(RW$(1)) < 6
      THEN
       7953:
      ELSE
       X = 212:
       GOTO 7975
7953 IF VAL(RW$(1)) < 5
      THEN
       7954:
      ELSE
       X = 219:
       RETURN
7954 IF VAL(RW$(1)) < 4
      THEN
       7955:
      ELSE
       X = 226:
       RETURN
7955 IF VAL(RW$(1)) < 3
      THEN
       7956:
      ELSE
       X = 233:
       GOTO 7979
7956 IF VAL(RW$(1)) < 2
      THEN
       7957:
      ELSE
       X = 240:
       RETURN
7957 IF VAL(RW$(1)) < 1
      THEN
       7958:
      ELSE
       X = 247:
       RETURN
7958 X = 194:
     RETURN
7961 IF VAL(RW$(2)) < 5
      THEN
       7962:
      ELSE
       X = 530:
       RETURN
7962 IF VAL(RW$(2)) < 4
      THEN
       7963:
      ELSE
       X = 538:
       GOTO 7983
7963 IF VAL(RW$(2)) < 3
      THEN
       7964:
      ELSE
       X = 546:
       GOTO 7988
7964 IF VAL(RW$(2)) < 2
      THEN
       7965:
      ELSE
       X = 554:
       RETURN
7965 IF VAL(RW$(2)) < 1
      THEN
       7966:
      ELSE
       X = 562:
       RETURN
7966 X = 517:
     RETURN
7971 IF VAL(RW$(3)) < 3
      THEN
       7972:
      ELSE
       X = 858:
       RETURN
7972 IF VAL(RW$(3)) < 2
      THEN
       7973:
      ELSE
       X = 867:
       GOTO 7992
7973 IF VAL(RW$(3)) < 1
      THEN
       7974:
      ELSE
       X = 876:
       RETURN
7974 X = 835:
     RETURN
7975 N = RND(3):
     ON N GOTO 7976,7977,7978
7976 RETURN
7977 PRINT @X - 64,HP$;:
     PRINT @X - 127,HO$;:
     PRINT @162,HJ$;:
     PRINT @99,HI$;:
     PRINT @169,HD$;:
     PRINT @106,HC$;:
     RETURN
7978 PRINT @X - 64,HD$;:
     PRINT @X - 127,HC$;:
     PRINT @176,HB$;:
     PRINT @113,HA$;:
     RETURN
7979 N = RND(3):
     ON N GOTO 7980,7981,7982
7980 RETURN
7981 PRINT @X - 64,HR$;:
     PRINT @X - 127,HQ$;:
     PRINT @176,HJ$;:
     PRINT @113,HI$;:
     RETURN
7982 PRINT @X - 64,HD$;:
     PRINT @X - 127,HC$;:
     PRINT @183,HJ$;:
     PRINT @120,HI$;:
     RETURN
7983 N = RND(4):
     ON N GOTO 7984,7985,7986
7984 RETURN
7985 PRINT @X - 64,HD$;:
     PRINT @X - 127,HC$;:
     PRINT @482,HJ$;:
     PRINT @419,HI$;:
     PRINT @498,HB$;:
     PRINT @435,HA$;:
     RETURN
7986 PRINT @X - 64,HB$;:
     PRINT @X - 127,HA$;:
     PRINT @482,HP$;:
     PRINT @419,HO$;:
     RETURN
7987 PRINT @X - 64,HR$;:
     PRINT @X - 127,HQ$;:
     PRINT @490,HD$;:
     PRINT @427,HC$;:
     RETURN
7988 N = RND(3):
     ON N GOTO 7989,7990,7991
7989 RETURN
7990 PRINT @X - 64,HD$;:
     PRINT @X - 127,HC$;:
     PRINT @490,HJ$;:
     PRINT @427,HI$;:
     RETURN
7991 PRINT @X - 64,HB$;:
     PRINT @X - 127,HA$;:
     PRINT @498,HP$;:
     PRINT @435,HO$;:
     RETURN
7992 N = RND(6):
     ON N GOTO 7993,7994,7995,7996,7997,7993
7993 RETURN
7994 PRINT @X - 64,HP$;:
     PRINT @X - 127,HO$;:
     PRINT @812,HR$;:
     PRINT @749,HQ$;:
     RETURN
7995 IF X3 < > 0
      THEN
       RETURN :
      ELSE
       PRINT @X - 64,HD$;:
       PRINT @X - 127,HC$;:
       PRINT @130,HJ$;:
       PRINT @67,HI$;:
       RETURN
7996 IF X3 < > 0
      THEN
       RETURN :
      ELSE
       PRINT @X - 64,HB$;:
       PRINT @X - 127,HA$;:
       PRINT @453,HP$;:
       PRINT @390,HO$;:
       RETURN
7997 IF X3 < > 0
      THEN
       RETURN :
      ELSE
       PRINT @X - 64,HD$;:
       PRINT @X - 127,HC$;:
       PRINT @771,HJ$;:
       PRINT @708,HI$;:
       RETURN
8000 PRINT @X,BA$;:
     PRINT @X + 64,BB$;:
     PRINT @X - 64,HB$;:
     PRINT @X - 127,HA$;:
     PRINT @X + 128,FC$;:
     RETURN
8005 GOSUB 8100:
     PRINT @X - 64,HD$;:
     PRINT @X - 127,HC$;:
     GOSUB 8100:
     PRINT @X - 64,HF$;:
     PRINT @X - 127,HE$;:
     GOSUB 8100:
     PRINT @X - 64,HH$;:
     PRINT @X - 127,HG$;:
     RETURN
8010 GOSUB 8100:
     PRINT @X - 64,HF$;:
     PRINT @X - 127,HE$;:
     GOSUB 8100:
     PRINT @X - 64,HD$;:
     PRINT @X - 127,HC$;:
     GOSUB 8100:
     PRINT @X - 64,HB$;:
     PRINT @X - 127,HA$;:
     RETURN
8015 GOSUB 8100:
     PRINT @X - 64,HJ$;:
     PRINT @X - 127,HI$;:
     GOSUB 8100:
     PRINT @X - 64,HL$;:
     PRINT @X - 127,HK$;:
     GOSUB 8100:
     PRINT @X - 64,HN$;:
     PRINT @X - 127,HM$;:
     RETURN
8020 GOSUB 8100:
     PRINT @X - 64,HL$;:
     PRINT @X - 127,HK$;:
     GOSUB 8100:
     PRINT @X - 64,HJ$;:
     PRINT @X - 127,HI$;:
     GOSUB 8100:
     PRINT @X - 64,HB$;:
     PRINT @X - 127,HA$;:
     RETURN
8025 M = RND(2) + 1:
     FOR L = 1 TO M:
      GOSUB 8100:
      PRINT @X - 64,HJ$;:
      PRINT @X - 127,HI$;:
      GOSUB 8100:
      PRINT @X - 64,HB$;:
      PRINT @X - 127,HA$;:
      GOSUB 8100:
      PRINT @X - 64,HD$;:
      PRINT @X - 127,HC$;:
      GOSUB 8100:
      PRINT @X - 64,HB$;:
      PRINT @X - 127,HA$;:
      NEXT L:
     RETURN
8030 GOSUB 8100:
     PRINT @X - 64,HP$;:
     PRINT @X - 127,HO$;:
     RETURN
8035 GOSUB 8100:
     PRINT @X - 64,HR$;:
     PRINT @X - 127,HQ$;:
     RETURN
8040 M = RND(3):
     FOR L = 1 TO M:
      GOSUB 8030:
      GOSUB 8100:
      PRINT @X - 64,HB$;:
      PRINT @X - 127,HA$;:
      GOSUB 8035:
      GOSUB 8100:
      PRINT @X - 64,HB$;:
      PRINT @X - 127,HA$;:
      NEXT L:
     RETURN
8045 GOSUB 8100:
     PRINT @X + 4,BE$;:
     PRINT @X + 68,BF$;:
     GOSUB 8100:
     PRINT @X + 4,BG$;:
     PRINT @X + 68,BH$;:
     GOSUB 8100:
     PRINT @X + 4,BI$;:
     PRINT @X + 68,BJ$;:
     GOSUB 8100:
     PRINT @X + 4,BK$;:
     GOSUB 8100:
     PRINT @X + 4,BL$;:
     RETURN
8050 GOSUB 8100:
     PRINT @X + 4,BK$;:
     X3 = X:
     GOSUB 8070:
     GOSUB 8070:
     X = X3:
     GOSUB 8110:
     PRINT @X + 4,BI$;:
     PRINT @X + 68,BJ$;:
     GOSUB 8100:
     PRINT @X + 4,BG$;:
     PRINT @X + 68,BH$;:
     GOSUB 8100:
     PRINT @X + 4,BE$;:
     PRINT @X + 68,BF$;:
     GOSUB 8110:
     PRINT @X + 4,BC$;:
     PRINT @X + 68,BD$;:
     RETURN
```

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by David H. Ahl

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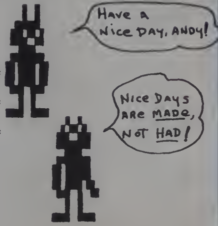
Android Nim, continued...

```
8055 GOSUB 8100:
     PRINT @X - 64,HD$;:
     PRINT @X - 127,HC$;:
     RETURN
8060 GOSUB 8100:
     PRINT @X - 64,HJ$;:
     PRINT @X - 127,HI$;:
     RETURN
8065 GOSUB 8100:
     PRINT @X - 64,HB$;:
     PRINT @X - 127,HA$;:
     RETURN
8070 M = RND(16):
     K = RND(50) + 50:
     Y = RND(18):
     GOSUB 8075:
      IF X3 = X
       THEN
        8070:
       ELSE
        IF X3 = 0
         THEN
          8071:
         ELSE
          IF (M < 8) OR (M > 12)
           THEN
            8071:
           ELSE
            8070
8071 IF M > 7
      THEN
       8089:
      ELSE
       ON M GOSUB 8005,8015,8030,8035,8055,8060,8065
8074 GOTO 8079
8075 ON Y GOTO 8076,8077,8078,7951,7952,7953,7954,7955
     ,7956,7957,7961,7962,7963,7964,7965,7971,7972,797
     3
8076 X = 194:
     RETURN
8077 X = 517:
     RETURN
8078 X = 835:
     RETURN
8079 X1 = RND(5)
8080 ON X1 GOTO 8081,8070,8081,8070,8081
8081 ON M GOTO 8087,8088,8082,8083,8084,8085,8086
8082 PRINT @X - 127,H4$;:
     GOSUB 8100:
     PRINT @X - 127,HO$;:
     RETURN
8083 PRINT @X - 64,H5$;:
     GOSUB 8100:
     PRINT @X - 64,HR$;:
     RETURN
8084 PRINT @X - 64,H2$;:
     GOSUB 8100:
     PRINT @X - 64,HD$;:
     RETURN
8085 PRINT @X - 64,H3$;:
     GOSUB 8100:
     PRINT @X - 64,HJ$;:
     RETURN
8086 PRINT @X - 64,HI$;:
     GOSUB 8100:
     PRINT @X - 64,HB$;:
     RETURN
8087 PRINT @X - 64,H6$;:
     GOSUB 8100:
     PRINT @X - 64,HH$;:
     RETURN
8088 PRINT @X - 64,H7$;:
     GOSUB 8100:
     PRINT @X - 64,HN$;:
     RETURN
8089 ON M - 7 GOTO 8090,8091,8092,8093,8094,8095,8096,
     8097,8098
8090 PRINT @67,HO$;:
     PRINT @130,HP$;:
     PRINT @390,HC$;:
     PRINT @453,HD$;:
     GOSUB 8100:
     RETURN
8091 PRINT @67,HQ$;:
     PRINT @130,HR$;:
     PRINT @708,HI$;:
     PRINT @771,HJ$;:
     GOSUB 8100:
     RETURN
8092 PRINT @390,HA$;:
     PRINT @453,HB$;:
     PRINT @708,HO$;:
     PRINT @771,HP$;:
     GOSUB 8100:
     RETURN
8093 PRINT @67,HQ$;:
     PRINT @130,HR$;:
     PRINT @390,HI$;:
     PRINT @453,HJ$;:
     PRINT @708,HO$;:
     PRINT @771,HP$;:
     GOSUB 8100:
     RETURN
8094 PRINT @390,HO$;:
     PRINT @453,HP$;:
     PRINT @67,HQ$;:
     PRINT @130,HR$;:
     GOSUB 8100:
     RETURN
8095 IF (X = 194) OR (X = 517) OR (X = 835)
      THEN
       8120:
      ELSE
       PRINT @X,BM$;:
       PRINT @X + 64,BN$;:
       GOSUB 8100:
       RETURN
8096 IF (X = 194) OR (X = 517) OR (X = 835)
      THEN
       8130:
      ELSE
       PRINT @X,BA$;:
       PRINT @X + 64,BB$;:
       GOSUB 8100:
       RETURN
8097 PRINT @X + 4,BO$;:
     PRINT @X + 68,BP$;:
     GOSUB 8100:
     RETURN
8098 PRINT @X + 4,BG$;:
     PRINT @X + 68,BH$;:
     GOSUB 8100:
     RETURN
8100 FOR N = 1 TO 8:
      NEXT N:
     RETURN
8110 RETURN :
     FOR N = 1 TO 50:
      NEXT N:
     RETURN
8112 FOR N = 1 TO 400:
      NEXT N:
     RETURN
8114 FOR N = 1 TO 200:
      NEXT N:
     RETURN
8116 FOR N = 1 TO 100:
      NEXT N:
     RETURN
8118 FOR O = 1 TO 3:
      GOSUB 8070:
      NEXT O:
     RETURN
8120 PRINT @X,BR$;:
     PRINT @X + 64,BN$;:
     GOSUB 8100:
     RETURN
8130 PRINT @X,BQ$;:
     PRINT @X + 64,BB$;:
     GOSUB 8100:
     RETURN
8200 X8 = 0:
      IF X9 = 2
       THEN
        7000:
       ELSE
        X3 = 0:
        PRINT @22,"*";:
        GOSUB 8070:
        K$ = INKEY$:
        IF K$ = ""
         THEN
          8200:
         ELSE
          IF (K$ > "0") AND (K$ < "4")
           THEN
            8210:
           ELSE
            IF K$ = "R"
             THEN
              7450:
             ELSE
              8200
8210 RW = VAL(K$):
     ON RW GOSUB 8410,8420,8430
8220 GOSUB 8070:
     K$ = INKEY$:
     IF K$ = ""
      THEN
       8220:
      ELSE
       IF (K$ > "0") AND (K$ < "8")
        THEN
         8225:
        ELSE
         IF K$ = " "
          THEN
           GOSUB 8325:
          ELSE
           8220
8221 GOTO 8200
8225 X9 = 2
8230 RN$ = K$:
     RN = VAL(RN$)
8240 IF (RN > VAL(RW$(RW))) AND (X9 = 1)
      THEN
       X8 = 1
8243 IF (RN > VAL(RW$(RW))) AND (X9 = 2)
      THEN
       X9 = 1
8245 ON RW GOSUB 8260,8270,8280
8247 IF ( VAL(RW$(1)) = 0) AND ( VAL(RW$(2)) = 0)
     AND ( VAL(RW$(3)) = 0)
      THEN
       7300
8250 IF X8 = 0
      THEN
       8200:
      ELSE
       7270
8260 PRINT @128,RN$;:
     X = 194:
     GOTO 8300
8270 PRINT @448,RN$;:
     X = 517:
     GOTO 8300
8280 PRINT @768,RN$;:
     X = 835:
     GOTO 8300
8300 GOSUB 8015:
     X3 = X:
     GOSUB 8070:
     X = X3:
     GOSUB 8060:
     GOSUB 8005:
     X3 = X:
     GOSUB 8070:
     X = X3:
     GOSUB 8010
```



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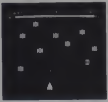

COSMIC FIGHTER

By Hogue & Konyu from Big Five
Terrific sound, graphics and unique chal lenges mark this new space game a winner! While fighting off the alien convoys — each more skillful than the last — you must keep track of your rocket fuel or risk explosion. Finally your space station appears. Can you dock immediately, or is the station overrun by aliens? Find out by ordering Cosmic Fighter today.

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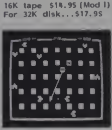
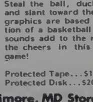
For 32K disk...$17.95



ATTACK FORCE!

By Hogue & Konyu from Big Five
Unlike the usual space "shoot em ups," At tack Force lets you control both speed and direction as you maneuver all over the screen in search of the alien Ramships and Flan ships. Enemy ships chase you everywhere, and the Flagships' lasers can fire in any dir ection! The Ramships can even impersonate your spacecraft, so don't look away even for an instant. Machine language action with sound.

16K tape $14.95 (Mod I) $15.95 (Mod III)
For 32K disk...$17.95



BASKET BALL

By John Allen from Acorn
You have to be fast to keep up with the action as you try to outscore your opponent in five minutes of one on one basketball against a friend or your computer.

Steal the ball, duck around your opponent and slant toward the basket for a lay up! The graphics are based on a 3 dimensional depic tion of a basketball court, and ball dribbling sounds add to the realism. It's all there but the cheers in this fast, machine language game!

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Protected Disk...$20.95

SUPERSCRIPT

By Richard Wilkes from Acorn
Using your SuperScript modified Scripsit Word Processor and a compatible printer, you can now underline, boldface, insert text during printout, slash zeros, set type pitch, subscript and, of course, superscript! You can even read your directory and kill files without ever leaving Scripsit.

SuperScript comes with drivers for popular serial and parallel printers (now including Centronics 737 and RS Daisy II), and easy in structions for patching to your Scripsit pro gram (does not include Scripsit).

Model I 32K disk...$29.95

DISASSEMBLER

By Roy Soltoff from Misosys & Acorn
A two pass disassembler for TRS 80 that con verts machine code to Z 80 assembly language listings. DISASSEMBLER produces symbolic labels with output to video, printer or tape. Radio Shack's Editor/Assembler will read and load the tapes for easy modification and re assembly. Extend the capabilities of Editor/Assembler with this utility. On tape for two different memory locations.

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Android Nim, continued...

```
8310 IF RN > VAL(RW$(RW))
      THEN
       8320:
      ELSE
       8400
8320 GOSUB 8025
8325 ON RW GOTO 8330,8340,8350
8330 PRINT @128," ";:
     PRINT @192," ";:
     RETURN
8340 PRINT @448," ";:
     PRINT @512," ";:
     RETURN
8350 PRINT @768," ";:
     PRINT @832," ";:
     RETURN
8400 GOTO 8405:
     GOSUB 8040:
     X3 = X:
     GOSUB 8070:
     X = X3:
     GOSUB 8005:
     X3 = X:
     GOSUB 8070:
     GOSUB 8070:
     X = X3:
     GOSUB 8045:
     GOSUB 8450:
     NEXT N:
     GOSUB 8500:
     GOSUB 8050:
     GOSUB 8010:
     GOTO 8325
8405 GOSUB 8040:
     GOSUB 8005:
     X3 = X:
     GOSUB 8070:
     X = X3:
     GOSUB 8045:
     GOSUB 8450:
     GOSUB 8500:
     GOSUB 8050:
     GOSUB 8010:
     GOTO 8325
8410 PRINT @192,"1";:
     RETURN
8420 PRINT @512,"2";:
     RETURN
8430 PRINT @832,"3";:
     RETURN
8450 ON RW GOTO 8460,8470,8480
8460 X = 254:
      IF VAL(RW$(1)) = 0
       THEN
        8461:
       ELSE
        FOR O = 1 TO VAL(RW$(1)):
         X = X - 7:
         GOSUB 8015:
         NEXT O
```

```
8461 X = 517:
     GOSUB 8030:
     X = 570:
     IF VAL(RW$(2)) = 0
      THEN
       8462:
      ELSE
       FOR O = 1 TO VAL(RW$(2)):
        X = X - 8:
        GOSUB 8030:
        NEXT O
8462 X = 835:
     GOSUB 8030:
     X = 885:
     IF VAL(RW$(3)) = 0
      THEN
       8463:
      ELSE
       FOR O = 1 TO VAL(RW$(3)):
        X = X - 9:
        GOSUB 8030:
        NEXT O
8463 X = 194:
     RETURN
8470 X = 570:
     IF VAL(RW$(2)) = 0
      THEN
       8471:
      ELSE
       FOR O = 1 TO VAL(RW$(2)):
        X = X - 8:
        GOSUB 8015:
        NEXT O
8471 X = 194:
     GOSUB 8035:
     X = 254:
     IF VAL(RW$(1)) = 0
      THEN
       8472:
      ELSE
       FOR O = 1 TO VAL(RW$(1)):
        X = X - 7:
        GOSUB 8035:
        NEXT O
8472 X = 835:
     GOSUB 8030:
     X = 885:
     IF VAL(RW$(3)) = 0
      THEN
       8473:
      ELSE
       FOR O = 1 TO VAL(RW$(3)):
        X = X - 9:
        GOSUB 8030:
        NEXT O
8473 X = 517:
     RETURN
8480 X = 885:
     IF VAL(RW$(3)) = 0
      THEN
       8481:
      ELSE
       FOR O = 1 TO VAL(RW$(3)):
        X = X - 9:
        GOSUB 8015:
        NEXT O
8481 X = 517:
     GOSUB 8035:
     X = 570:
     IF VAL(RW$(2)) = 0
      THEN
       8482:
      ELSE
       FOR O = 1 TO VAL(RW$(2)):
        X = X - 8:
        GOSUB 8035:
        NEXT O
8482 X = 194:
     GOSUB 8035:
     X = 254:
     IF VAL(RW$(1)) = 0
      THEN
       8483:
      ELSE
       FOR O = 1 TO VAL(RW$(1)):
        X = X - 7:
        GOSUB 8035:
        NEXT O
8483 X = 835:
     RETURN
8500 Z1 = VAL(RW$(RW)):
     Z2 = Z1 - RN:
     RW$(RW) = STR$(Z1 - RN)
8520 ON RW GOTO 8530,8540,8550
8530 Z$ = "=---":
     Z3 = 205:
     Z4 = 7:
     Z5 = 254 - 7 * Z1:
     GOTO 8560
8540 Z$ = "=---":
     Z3 = 528:
     Z4 = 8:
     Z5 = 570 - 8 * Z1:
     GOTO 8560
8550 Z$ = "=---":
     Z3 = 846:
     Z4 = 9:
     Z5 = 885 - 9 * Z1:
     GOTO 8560
8560 FOR M = 1 TO RN:
      PRINT @Z3 - 1,"=";:
      FOR N = Z3 TO Z5 STEP 3:
       PRINT @Z3 - 1,"-";:
       PRINT @N,Z$;:
       PRINT @Z3 - 1,"=";:
       NEXT N:
      PRINT @Z5,FA$;:
      PRINT @Z5 + 64,FA$;:
      PRINT @Z5 - 64,FA$;:
      PRINT @Z5 + 128,FA$;:
      PRINT @Z5 - 128,FA$;
8570  PRINT @Z5,FB$;:
      PRINT @Z5 + 64,FB$;:
      PRINT @Z5 - 64,FB$;:
      PRINT @Z5 + 128,FB$;:
      PRINT @Z5 - 128,FB$;:
      FOR N = Z3 TO Z5 STEP 3:
       PRINT @N,"    ";:
       NEXT N
8580  Z5 = Z5 + Z4:
      NEXT M
```

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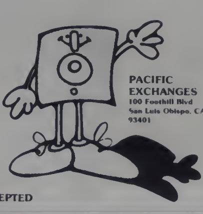

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Android Nim, continued...

```
8590 Y9 = Y9 + 1:
     X3 = X:
     GOSUB 8070:
     X = X3:
     RETURN
9000 HA$ = CHR$(160) + CHR$(181) + CHR$(186) +
     CHR$(144)
9001 HB$ = CHR$(128) + CHR$(143) + CHR$(182) +
     CHR$(185) + CHR$(143) + CHR$(128)
9002 HI$ = CHR$(128) + CHR$(143) + CHR$(183) +
     CHR$(187) + CHR$(143)
9005 HC$ = CHR$(160) + CHR$(186) + CHR$(176) +
     CHR$(149)
9006 HD$ = CHR$(128) + CHR$(143) + CHR$(189) +
     CHR$(179) + CHR$(142) + CHR$(128)
9007 H2$ = CHR$(128) + CHR$(143) + CHR$(191) +
     CHR$(179) + CHR$(143)
9010 HE$ = CHR$(160) + CHR$(176) + CHR$(181) +
     CHR$(149)
9011 HF$ = CHR$(128) + CHR$(143) + CHR$(191) +
     CHR$(189) + CHR$(135) + CHR$(132) + CHR$(128)
9015 HG$ = CHR$(160) + CHR$(176) + CHR$(186) +
     CHR$(144)
9016 HH$ = CHR$(128) + CHR$(143) + CHR$(191) +
     CHR$(191) + CHR$(142) + CHR$(132) + CHR$(128)
9017 H6$ = CHR$(128) + CHR$(143) + CHR$(191) +
     CHR$(191) + CHR$(143) + CHR$(132)
9020 HI$ = CHR$(170) + CHR$(176) + CHR$(181) +
     CHR$(144)
9021 HJ$ = CHR$(128) + CHR$(141) + CHR$(179) +
     CHR$(190) + CHR$(143) + CHR$(128)
9022 H3$ = CHR$(128) + CHR$(143) + CHR$(179) +
     CHR$(191) + CHR$(143)
9025 HK$ = CHR$(170) + CHR$(186) + CHR$(176) +
     CHR$(144)
9026 HL$ = CHR$(136) + CHR$(139) + CHR$(190) +
     CHR$(191) + CHR$(143) + CHR$(128)
9030 HM$ = CHR$(160) + CHR$(181) + CHR$(176) +
     CHR$(144)
9031 HN$ = CHR$(136) + CHR$(141) + CHR$(191) +
     CHR$(191) + CHR$(143) + CHR$(128)
9032 H7$ = CHR$(136) + CHR$(143) + CHR$(191) +
     CHR$(191) + CHR$(143)
9035 BA$ = CHR$(184) + CHR$(135) + CHR$(191) +
     CHR$(191) + CHR$(139) + CHR$(180)
9036 BB$ = CHR$(130) + CHR$(141) + CHR$(151) +
     CHR$(171) + CHR$(142) + CHR$(129)
9040 FC$ = CHR$(136) + CHR$(140) + CHR$(133) +
     CHR$(138) + CHR$(140) + CHR$(132)
9050 HO$ = CHR$(160) + CHR$(164) + CHR$(152) +
     CHR$(144)
9051 HP$ = CHR$(128) + CHR$(143) + CHR$(189) +
     CHR$(190) + CHR$(143) + CHR$(128)
9052 H4$ = CHR$(160) + CHR$(180) + CHR$(184) +
     CHR$(144)
9055 HQ$ = CHR$(160) + CHR$(180) + CHR$(184) +
     CHR$(144)
9056 HR$ = CHR$(128) + CHR$(175) + CHR$(155) +
     CHR$(167) + CHR$(159) + CHR$(128)
9057 H5$ = CHR$(128) + CHR$(175) + CHR$(159) +
     CHR$(175) + CHR$(159)
9060 BC$ = CHR$(139) + CHR$(180)
9061 BD$ = CHR$(142) + CHR$(129)
9065 BE$ = CHR$(191) + CHR$(128)
9066 BF$ = CHR$(143) + CHR$(128)
9070 BG$ = CHR$(191) + CHR$(128) + CHR$(128)
9071 BH$ = CHR$(130) + CHR$(141)
9075 BI$ = CHR$(191) + CHR$(176) + CHR$(176) +
     CHR$(128) + "  "
9076 BJ$ = CHR$(128) + CHR$(128)
9080 BK$ = CHR$(139) + CHR$(180) + CHR$(156) + ",-= "
9085 BL$ = STRING$(4, CHR$(131)) + "'-="
9090 BM$ = CHR$(128) + CHR$(191) + CHR$(191) +
     CHR$(191) + CHR$(171) + CHR$(148)
9091 BN$ = CHR$(142) + CHR$(129) + CHR$(151) +
     CHR$(171) + CHR$(142) + CHR$(129)
9095 BO$ = CHR$(171) + CHR$(148):
     BP$ = CHR$(130) + CHR$(141)
9100 FA$ = STRING$(6, CHR$(191)):
     FB$ = STRING$(6, CHR$(128))
9105 BR$ = CHR$(128) + CHR$(191) + CHR$(191) +
     CHR$(187) + CHR$(171) + CHR$(148)
9110 BQ$ = CHR$(184) + CHR$(135) + CHR$(191) +
     CHR$(187) + CHR$(139) + CHR$(180)
9200 A$ = CHR$(191):
     MA$ = A$ + A$ + "      " + CHR$(175) + A$
     + CHR$(148) + "  " + CHR$(190) + A$ + CHR$(189)
     + "  " + CHR$(168) + A$ + CHR$(159) + " "
     + A$ + A$ + " " + A$ + A$ + CHR$(175) + CHR$(189)
      + CHR$(144) + "  " + A$ + A$
9210 MB$ = A$ + A$ + "      " + CHR$(130) + A$
     + A$ + CHR$(144) + CHR$(186) + A$ + CHR$(131)
     + A$ + CHR$(181) + CHR$(160) + A$ + A$ +

     CHR$(129) + " " + A$ + A$ + " " + A$ + A$
     + " " + CHR$(139) + A$ + CHR$(180) + " "
     + A$ + A$
9220 MC$ = A$ + A$ + "       " + CHR$(138) + A$
     + CHR$(189) + A$ + CHR$(135) + " " + CHR$(139)
     + A$ + CHR$(190) + A$ + CHR$(133) + "  "
     + A$ + A$ + " " + A$ + A$ + "  " + CHR$(130)
     + CHR$(175) + CHR$(189) + A$ + A$
9300 RETURN
10000 CLS :
      GOSUB 7600
10010 K$ = INKEY$:
      IF K$ = ""
       THEN
        10010:
       ELSE
        10000
10020 PRINT "WHEN YOU SEE AN (*) TO THE LEFT OF 'ANDROI
      D NIM' ITS YOUR TURN."
10030 PRINT :
      PRINT "YOU NEED NOT PUSH ENTER, JUST THE ROW NUMB
      ER, 1 2 OR 3,"
10040 PRINT "AND THE NUMBER OF ANDRIODS YOU WISH TO HAV
      E REMOVED."
10060 PRINT "IF YOU WISH TO GIVE UP, PUSH THE 'R' KEY."
10080 PRINT :
      PRINT "RULES - - YOU MAY REMOVE AS MANY ANDROIDS
      FROM ANY"
10090 PRINT "ROW AS YOU WISH WHEN IT IS YOUR TURN.  TO
      WIN YOU MUST"
10100 PRINT "REMOVE THE LAST ANDROID."
10110 PRINT :
      INPUT "PUSH ENTER WHEN READY & WAIT A BIT";X:
      GOTO 10
```

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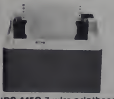

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Richard Hackmeister

From sound effects on digital discs to real-time image simulation, the computers of Hollywood are working behind the scenes to expand the artistic capabilities and productivity of the film industry. Borrowing and adapting technologies from fields such as flight simulation and industrial automation, movie makers and animation houses are turning out a higher quality product quicker. Computer aids enhance the creativity of sound editors, animators and other film artists, while freeing them from time-consuming, pedestrian tasks. Hollywood is cranking out twice the film it did a decade ago, business is booming, and computers have played a strong supporting role.

With audiences demanding more sophisticated special effects in films and a larger supply of films, producers have been using computers in ever-greater numbers and for more applications. Both film and television now benefit from well-stocked, easily accessible and manipulable digital sound effects stored on discs. Films for TV commercials have gotten a boost from computerized drawing boards that help the artists prepare animation sequences. And the special effects in the recent rash of science fiction movies have been made possible by computerized camera control.

The great popularity of recent science fiction movies is partly attributable to Hollywood's delivery of impressive special effects. Movies like *The Black Hole* would be extremely difficult, if not impossible, to make without computerized camera positioning systems for filming scale models, and *Star Trek* would have been bland without a computerized multiplane camera to create depth and animation from static two-dimensional artwork.

Walt Disney Studios (Burbank, CA) made *The Black Hole* with the ACES up its sleeve—i.e. its Automated Camera Effects System. ACES is a computer-controlled camera platform coordinated with a computer-controlled model platform. The system, which made a ten-foot scale model look like a mile-long space colony, provides film makers with the very best capabilities of the machine-tool industry: the precise positioning and repeatability, fast servo control, and good noise immunity that model filming requires.

Movies like The Black Hole would be extremely difficult, if not impossible, to make without computerized camera positioning systems for filming scale models.

ACES uses a "key position" technique to identify nodes of camera travel. The camera operator first defines the points for a filming sequence via a keyboard. Then, the system software interpolates between nodes and automatically tracks the camera along the appropriate course to gain the desired effect.

ACES' camera dolly can move along a 46-foot long track at 3 1/2 feet per second, yet position itself with an accuracy of 0.01 inch. Its camera can roll through 720 degrees at 36 degrees per second, yet position itself with an accuracy of 0.01 degree. System software contains a variety of safety checks and warnings to prevent damage to people and props. When the system's processor (a Data General Nova 312 with 64K words of memory) recognizes a hazard within a calculated move, it won't execute that move.

ACES includes an instant replay system that simulates the "take" on video disc. No film is exposed unless a scene is exactly correct. Also, the combination of dolly and camera moves executed in scenes is put onto floppy disc for archival storage. Any take can, thus, be reproduced if a flaw is later discovered.

"During eleven months of filming *The Black Hole*," notes David Inglish, Disney's key ACES engineer, "we used eleven floppy discs to record everything. There is enough room on each disc to hold 99 takes, but most are nowhere full. Floppy disc is an ideal way to store the information because if the archives were to be printed on paper, it would easily fill a five-drawer file cabinet."

Inglish, who was closely involved in the design and implementation of ACES, emphasizes the system's reliability.

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Computerized camera platforms and scale-model platforms helped provide the special effects for Walt Disney Studios' The Black Hole. *Automated camera motion, rotation and focusing made a ten-foot model look like a mile-long space colony.*

"Down time can cost as much as $10,000 per day in production costs, but during the entire eleven months of shooting, we lost only four hours." The problem, Inglish says, was quickly diagnosed as a faulty capacitor in a memory bank, and most of the four-hour delay was the time needed to get a new tantalum capacitor. The movie studio now keeps spare parts on hand.

Star Trek, another science fiction film with impressive special effects, was made at Paramount Studios with a similar computerized camera system called COMPSY—Computerized Multiplane System. COMPSY updates the multiplane imaging technique first developed by Disney Studios in the early 1930s. Then, a camera moved past 8 or 10 sheets of glass painted with different details of a scene and stacked in series. When screened, the paintings closest to the camera seemed to move more quickly and to be part of the foreground, while details at the back appeared to be in the distance.

COMPSY reduces the required multiplane images to just one piece of flat art. The computer generates spatial-dynamic effects by multiple-exposing the art from different perspectives, so images stack up on film to create the illusion of depth. Typically, art work is painted on a 38 x 80 inch transparency called a cel, which is then mounted in a light box at the end of a 36-foot track.

An animation camera on a dolly is mounted on a computer-controlled platform that traverses the track. The dolly and the camera's focus and axes are under the control of the system's DEC LSI-11 microcomputer. COMPSY generates standard camera moves and sequences—e.g. logarithmic acceleration to a specified closing rate, close logarithmic deceleration and stop—and non-standard moves.

"Non-standard moves are too complex to easily describe," says Evans Wetmore, a Manhattan Beach, California film-industry consultant who designed a major part of COMPSY. "If the director gestures in the air with his hands and says, 'I want the scene to look like *this*....', that's a non-standard move."

The oldest and most pervasive use of programmable computers in the film industry is in sound editing.

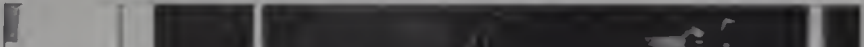
To accommodate these moves, Wetmore designed COMPSY to track a cameraman's actions and capture the camera's movement in memory. Once in memory, the minicomputer can stretch or compress them, and play back a combination of moves simultaneously to produce special effects. With this technique, *Star Trek's* creators were able to make the starship Enterprise look like stretched taffy when it went "into warp drive."

A computerized animation control system similar to COMPSY is being marketed by Robert Able & Associates, an award-winning animation house specializing in commercial TV spots. The 12-channel system is base priced at $149,900, wired to suit the user's animation camera, and can be expanded to up to 16 channels at a cost of $2500 per channel.

Computer aids are also having a substantial impact on the animation field, especially for TV commercials. Composing a properly organized animation sequence is a difficult task. A sequence is filmed one frame at a time and played back at a standard rate of 24 frames per second. The action ("moves" in animation parlance) of the sequence is the result of slight changes in the image from one frame to the next. A 60-second TV spot requires 1440 individual frames. Computerized systems are currently simplifying the artist's task by generating and manipulating images for direct filming of line drawings, and by providing an outline of moves for more complicated images.

Able & Associates uses a "move generation system" to assist its staff of artists. Originally designed as a flight simulator, the system assures that moves are evenly distributed over a sequence and that the sequence itself begins and ends where it should.

Commercials can be filmed directly from the 21-inch vector graphic display unit, but only in the form of line drawings. An artist first draws three orthogonal views (top, front, and right side) of the product to be animated. The digitizer "translates" the drawings into numerical points for the computer. Once all three views are stored in memory, the processor



In Disney's ACES (Automated Camera Effects System), a Fortran-programmed minicomputer stores and controls predetermined moves. The camera dolly, moving along a 46-foot track at 3½ feet per second, is accurate to 0.01 of an inch.

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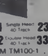

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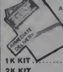

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8257	19 50	8T98	1 19
8259	19 50	6850	9 95
[illegible]10	4 75	6820	9 75
[illegible]	3 90	6822	9 75
68[illegible]	3 50	[illegible]	10 95
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generates a unified perspective image of the object, and can rotate it in free space, move it closer and further away, and otherwise manipulate it for the animation camera.

The system's 21-inch CRT, operating with a fast vector graphics display, produces a white image with high resolution—4096 x 4096 pixels and 256 grey levels. Interposing colored filters between the display and the camera produces animated, color line drawings.

The move generation system can also be used to provide a "pencil test" for animated artwork—an outline of sequence moves. When used in this fashion to preview a sequence, the system operates in much the same way as it does when animating lines, except that the computer-generated images serve only as models for further enhancement by animators. Once previewed on the imaging display, individual frames of a sequence are hand-illustrated on 8 x 10 inch transparent cels, which are then filmed for projection at 24 frames per second.

Able & Associates' flexible, real-time simulation system was put together inhouse, and at no small cost. But for animators on a shoestring, a commercially available pencil-test system can be purchased for as little as $8500 from Lyon-Lamb Company (Los Angeles, CA).

The Lyon-Lamb single-frame video animation system uses little more than a zoom lens camera, a video recorder and a 9-inch monitor. The artist sketches frames and depresses a foot pedal to take "pictures" of them. Sequential video frames are put onto magnetic tape, and when the sequence is complete, it is played back at a real-time rate. A $2800 option allows the animator to "trace" the real-time moves of objects on film.

Sophisticated as they presently are, computer animation aids are still incapable of producing electronically generated cels. Full-color raster graphic systems that could produce and animate art of the caliber of hand-drawn images remain a long way off. The major impediment is the cost of applicable hardware and software.

Grant Snellen, director of engineering for Able & Associates, estimates that it would take a $50 million commitment to overcome barriers to computerized animation. The major elements of the necessary technology already exist and are commercially available: full-color 10 x 10 inch computer output microfilm with 1000 lines-per-inch resolution and fast (20,000 data bytes per second) writing rate is available in an optical plotter from Optronics International (Chelmsford, MA); and of course, computers with the required power are available from several companies. However, the software to tie the two together is lacking.

"If and when a computerized animation system emerges," says Snellen, "it will operate on the principle of inputting key frames to the system that depict just the beginning and end frames of animated moves. The processor supposedly would aid the artist by generating intermediate frames."

The oldest and most pervasive use of programmable computers in film industry is in sound editing. Since 1970, automatic dialogue replacement (ADR) systems have been helping to synchronize revoicing, overdubbing and sound effects with the visual portion of a film. More recently, microcomputer-based disc libraries of sound effects have been easing the job of sound editors and expanding their capabilities.

The minicomputer-based ADR system from Magnetec (New York, NY) is a multi-channel controller that cues voice actors and sound effects editors when to begin a scene, and paces them through the scene. Dolby recording techniques and logarithmic faders blend new dialogue and sound effects into as many as 30 different tracks. "ADR systems have become very popular, and are used in some 90% of all professional studios," observes Don Rogers, technical director of Samuel Goldwyn Studios.

"I can stretch a sound or shrink it to get just the right coloring before putting it to film."

Rogers, who also chairs the Motion Picture Academy's Science and Technology Committee, notes that computer technology has contributed significantly to the film industry. To acknowledge this contribution and foster futher innovation, the Academy directors presented a special technology award this April for "an automated, computer-controlled editing sound system that stores digitized sound effects on disc and provides instant access to them."

This special award for ACCESS, a microcomputer-based disc library and editing system, was presented to Neiman-Tillar Associates (Hollywood, CA), owners and users of the system, and to William R. Dietrich and Mini-Micro Systems, Inc. (Anaheim, CA) for its hardware and software design. ACCESS reduces a 15-to-20 minute editing task to a few seconds.

ACCESS contains a complete sound effects library in pulse code modulation—a method of storing sound in digital form. The system's video terminal displays an index of a wide variety of sounds (e.g. chirping crickets, an automobile crash) that can last up to 30 seconds. These sounds are called up and manipulated via the system keyboard to augment the visual action.

When movies are shot, the sounds accompanying on-screen action are not recorded along with the visual portion of the film. Unsightly microphones and wires mar the camera's field of view, and sound needs to be more tightly controlled than it can be during shooting. Appropriate footsteps, bells, sirens, etc. are added by sound editors after filming.

In conventional editing, required sounds are stored in a vast library of audio tapes. The sound editor views portions of a film in a sound editing machine called a "Moviola," decides what sounds are needed, and trundles off to the audio library to locate the sound he needs. The editor duplicates an amount of the proper tape on 35mm magnetic stripe film, then returns to the Moviola and splices the tape onto the film portion. If the editor is not satisfied with the result, his only recourse is to scrape the tape with a razor blade or wipe it off with acetone, and try again.

"The advantage of ACCESS over normal sound editing machines is that it combines a sound effects library and editing machine in a single system," notes Larry Neiman, president of Neiman-Tillar Associates. Since a sound effect and its corresponding film portion are coordinated inside the computer's memory before being committed to a physical medium, an incorrect sound effect can be simply overlaid with another, instead of being discarded.

"And since the system has so much flexibility," notes Neiman-Tillar sound editor Pamela Bentkowski, "I can stretch a sound or shrink it to get just the right coloring before putting it to film." Ms. Bentkowski edited sound effects with a Moviola for years before switching to the ACCESS system. She feels very comfortable using ACCESS, although she has had no computer training. "It's a valuable tool for our industry. It certainly can't replace any artists, but it expands our capabilities and eliminates a lot of wasted time."

William Dietrich of Mini-Micro Systems custom-designed ACCESS. He reports that it took 18 months to design ACCESS, program it in assembly language, and debug it—at a cost of about $500,000. Mini-Micro Systems is now offering similar systems to the film industry at large.

ACCESS is configured around two 8080 microprocessors from Intel Corp. (Santa Clara, CA). The system includes 1400 megabytes of off-line removable disc storage for the sound effects library, and another 50 Mbytes for on-line working files. The microprocessors have access to a quarter-million bytes of fast semiconductor memory. Sound effects are sampled at 20-microsecond intervals (50 kHz) with an accuracy of 12 bits per sample. Also included in the system are a matrix printer, a video tape deck, several TV monitors (one used as a volume-unit meter), and time-code generators that identify each frame.

Film makers have always been responsive to audience demands for perfection. Film technology has been pulled from black-and-white to color, and from monophonic sound to stereo, quad, sound-surround and now to Dolby recording techniques. The audience, in turn, has responded well to the industry's technical improvements. "Just displaying the Dolby logo on a theater marquee adds to a film's gross earning," Don Rogers of the Motion Picture Academy points out.

Film audiences are now pulling the industry toward computerized film aids by their avid acceptance of highly stylized commercials and awesome special effects. And the film industry is moving quickly to meet the demand. "Perhaps the greatest challenge of COMPSY," says Evans Wetmore, "was that we designed and built in only seven weeks. □

Software Techniques of Digital Music Synthesis

Part 1

Hal Chamberlin

The author has been active in electronic sound synthesis since 1966 and in computer music synthesis since 1970. He has published numerous articles about this and other topics in a number of magazines including the first hobby computer magazine, The Computer Hobbyist. *He has recently published a book entitled* Musical Applications of Microprocessors *with Hayden Book Co. which describes computer music synthesis in detail. He currently works for Micro Technology Unlimited, a manufacturer of 6502 system components, where he is Vice President of Research and Development.*

Music synthesis seems to be one of the fastest growing applications of small computers. Every new magazine issue announces a new synthesizer board, music program, or packaged system with music capability. Even in the pages of *Creative Computing*, as much space seems to be devoted to discussion of music related products as to word processing which is probably the current top application area (besides games of course).

Although the title implies concentration on software based computer music synthesis, it is important to briefly examine the entire field of computer music first. This will enable us to recognize the place of software synthesis and to objectively evaluate its strengths as well as weaknesses. To many, the following treatment will seem to be oversimplified and as a consequence not perfectly accurate. To others it should be an enlightening breath of fresh air in a field with more than its share of opinions, misconceptions, and hearsay. In any case, referral to the bibliography will carry the reader as far as desired into this truly fascinating computer application.

Hal Chamberlin, Rt. 1 Box 365, Wake Forest, NC.

Who Uses Computer Music?

Before looking at the computer music family tree, let's find out who actually uses computer music systems and for what purpose. It goes without saying that a large number of people view and use computer music casually as an entertaining computer "game" that is fundamentally different from the usual competitive or simulation game. Others may buy a music program in hopes that they can learn "all about music" from it since they never did as children. Still others may wish to show off their creative skills or the computer itself to relatives and house guests.

Then we have the educational applications which can be divided into at least three levels. The lowest level is concerned with teaching the basic concepts of pitch and rhythm and how to correlate the sound heard with music notation. The next level is concerned with harmony, composition, and the nuances of sound that give "life" to performances. Then of course every music department has researchers investigating new composition styles and the sonorities to complement them with the aid of computer music systems.

Electronic and computer music today makes a fascinating hobby which has many of the qualities the computer hobby itself had in the early 1970's before fully packaged personal computers were available. Some may be just casually trying out some things they have read about while others may be serious about building viable computer music systems. The very serious hobbyists seek to combine synthesis techniques in new ways to get new sounds. With the state of computer music today, much significant work is being performed by these individuals.

We should be careful not to leave out professional musicians either. The performer in a neighborhood band may wish to use the computer to provide a different sound for a couple of numbers. The keyboard player of a larger group may add a computer based synthesizer to his keyboard collection or use a programmable synthesizer to provide a repetitive background. A commercial music producer can use a computer to speed up the process of composing, perfecting, and synchronizing music to the imagery being illustrated. As a matter of fact, the majority of background music in TV shows, radio advertisements, and movies *is* synthesized nowadays although usually not by a computer — at least not yet.

These are just some of the uses to which computer music is being put currently but the real potential for consumers has not even been addressed yet. Learning and playing music today is primarily a *physical* activity, not really unlike playing basketball. Of course there is some theory and logic included in music training but the emphasis is on dexterity, technique, and practice. Just as there are probably over a million "basketball players" in this country but only a handful of really good ones, there are millions of people involved in music but only a few that are outstanding. Computers have the potential to eliminate physical factors from the composition and performance of music and thus make it a purely *mental* endeavor. In other terms, millions of people with the mind for music but not the body can now become involved and make significant contributions.

Each of these users and applications has need for a different kind of computer music system. The rank beginner or casual user needs a simple system that's easy to use and gives immediate results. The professional user and researcher is constantly searching for new capability and is not afraid to tackle any new complexities that may accompany it.

The Computer Music Family Tree

Figure 1 should aid in understanding the diversity of approaches taken in music

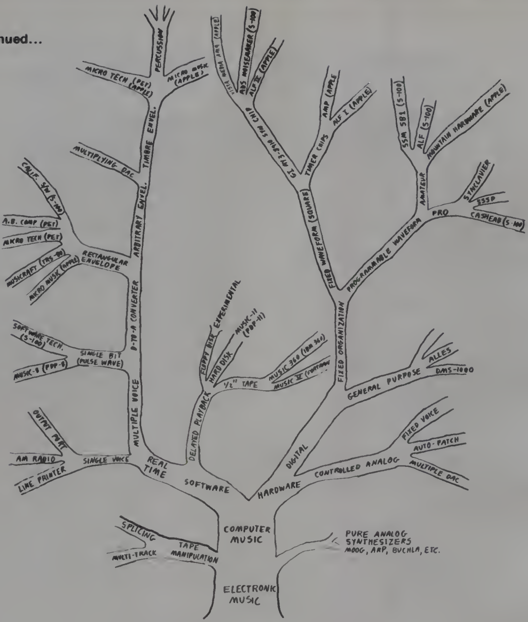

Figure 1 The Computer Music Family Tree.

synthesis. Actually the taxonomy of electronic music is considerably more involved than the diagram indicates. The commercial products cited are merely the best known ones and in no way represent all that are available. In addition, emphasis is given to products that would be practical for an individual to own.

In reality computer music is just a branch of the electronic music tree. Complex musical sounds may also be synthesized by means of tape manipulations and with voltage-controlled analog synthesizers. Once into computer music, there is an immediate split between hardware and software techniques. The difference is that hardware techniques always involve a *synthesizer peripheral* that is connected to the computer. The music program merely *controls* this peripheral much like a listing program controls a printer to produce a document. Software techniques on the other hand use a relatively simple *conversion peripheral* which converts an internal representation of sound into an external representation that can be heard. The music program actually *simulates* the synthesizer as well as controls it!

Looking at the hardware side of the tree first, we see that the synthesizer peripheral may either use primarily analog circuitry or digital circuitry in its implementation. Computer control of analog synthesizers is actually of considerable interest to professional and academic users at this time. Often computers are used merely to automatically set up the dozens of patched connections typically required by an analog synthesizer much like replacing an old-fashioned telephone switchboard with a modern electronic one. In more sophisticated installations, the computer can also "play" the synthesizer through an interface consisting of dozens of digital-to-analog converters. The fixed voice synthesizer is primarily applicable to pipe organ replacements where each synthesizer board is designed for a particular instrument or stop.

Digital synthesizers are built with logic circuits just like computers but the "architecture" is optimized for high-speed sound wave computations. Some digital synthesizers are *programmable* which means that they may be restructured on command from the host computer. These are very flexible but tend to be large machines confined to the experimental music studios of large universities. The DMS-1000 unit from Digital Music Systems is more modest in its size (and capabilities) however. Most digital synthesizers have a fixed organization instead which greatly reduces their cost. Fixed organization means that parameters such as the number of simultaneous voices and the waveform computation algorithm are fixed by design.

The simplest digital synthesizers also have a fixed square waveform which

ALF Music Synthesizer

The ALF Apple Music Synthesizer (AMS) is an easy to use peripheral which allows you to program music into an Apple II computer using standard musical notation. The ALF kit includes the synthesizer board (plugs into any peripheral slot), exceptional quality software, and an extensive user manual.

Sophisticated Music Entry Program

Sheet music is easily entered using the Apple game paddles. The high-resolution ENTRY program features the familiar music staff with a "menu" of musical items listed beneath it (note lengths, rests, edit commands, accidentals, etc.). One game paddle moves a cursor up and down the music staff and is used to select the note pitch; the second paddle chooses from the menu items (note length, etc.) With the ALF hi-res ENTRY program, you won't have to use cryptic codes to select note parameters.

As you program sheet music with ENTRY, measure bars are inserted automatically (and note values are tied over the bar where necessary). Key signatures are also automatic—you don't have to keep writing in every sharp or flat!

Three monophonic, individual parts can be programmed with each ALF Music Synthesizer. Two boards are required for stereo. A total of three synthesizers can be used simultaneously for a maximum of nine voices. By controling the envelope (or shape) of each voice, many different instrumental sounds can be simulated.

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The ALF Music Synthesizer has a pitch range of eight octaves—a wider range than a grand piano. The ALF can also play semitones—"blues notes" or the pitches in between the keyboard notes of a piano. (The pitch range is from 27.5 to 55,000 Hertz, well beyond the limits of human hearing.) Tuning accurancy is virtually perfect within two cents of pitch value.

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You can save songs on either cassette or disk, and play them back using either ENTRY or PLAY. The playback speed is adjusted with one of the game paddles, and can be varied during the playback, if you wish to change the overall tempo.

Colorful Playback Display

The ALF Music Synthesizer features a 16-color low-res graphic display during song playback. Each musical part is represented on a stylized piano "keyboard"—the intensity of the note determines the color, and the pitch is shown in relation to "middle C".

The ALF Music Synthesizer requires the use of an external audio amplifier. Stereo programming is possible with the use of two or three synthesizer boards.

The ALF software includes the ENTRY and PLAY programs, sample songs, an introduction to "envelope shaping", and demonstrations of advanced uses of the synthesizer.

With the ALF software, entry of music is easy, fast and accurate.

Nine Voices for only $198

The new ALF "AM-II" music synthesizer offers an unbeatable value for the Apple owner who is a music hobbyist. With nine voices on a single music board for $198.00, the AM-II is the most economical device for creating music with the Apple.

The AM-II uses the same excellent ENTRY and PLAY programs as the more sophisticated ALF Music Synthesizer (AMS); the same hi-res graphic display from which notes are selected with the Apple game paddles (not typed with cryptic codes). All of the conveniences of the ENTRY program apply—easy editing, playback with low-res display, ability to save songs on cassette or disk, etc.

The AM-II has **stereo output** (3 voices in left, 3 voices in the middle, 3 voices in the right).

How can the AM-II offer so much for only $198.00? The two basic differences between the AM-II and the ALF Apple Music Synthesizer (AMS) are pitch accuracy and dynamic range. The AM-II has an accurate pitch range of about six octaves. Pitch values above the treble staff become increasingly inaccurate. Also, the AM-II has a dynamic range of 28db, with 16 different volume levels, (the AMS has a dynamic range of 78db).

The AM-II is manufactured with the same high quality standards as other products from the ALF Corporation. No sacrifice has been made in reliability; the new AM-II is simply a great bargain.

Professional musicians will still want to use the original Apple Music Synthesizer (AMS) for its extended range and volume controls (the AMS has a range of 8 octaves). But for the Apple owner who is interested in music as a hobby, the AM-II is the best music peripheral value available today.

Requires: 16K Apple II or Apple II Plus, cassette or Disk II, and an external audio amplifier (all necessary patch cords are included).

AM-II ALF/Apple Synthesizer	$198.00
AMS ALF/Apple Synthesizer	248.00

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eliminates waveform computation in the synthesizer altogether. These are abundantly available for most small computers. In fact, a "digital synthesizer on a chip" is now available from General Instruments which provides three square-wave voices, a white noise voice (for percussion), and a separate amplitude envelope for each of the 4 sounds. While this chip has accelerated the introduction of music peripherals for personal computers, its modest capabilities limit use in serious applications. The primary defect is its fixed square waveform which sounds basically like a kazoo.

Programmable waveform synthesizers can generate a much wider variety of sounds and thus are suitable for the more sophisticated applications. Along the professional branch we have very comprehensive units such as the Synclavier which has 32 voices of *dynamically reprogrammable* waveforms. A less expensive example is the Casheab S-100 plug-in synthesizer which has 16 dynamically reprogrammable voices. Waveform variation during a note is necessary for realistic instrument simulation as well as for most "synthesizer sounds" and is expected in a professional unit. The "amateur" units represented typically have fewer voices and only statically reprogrammable waveforms (no provision for smooth waveform change during a note) as well as a much lower cost. The two systems to the left utilize "voice per board" organization which means that multiple synthesizer boards are needed for multiple voices. The one on the right is a recent introduction that can create 16 voices on two boards giving a much lower cost per voice.

Turning to the software side of the tree we see an immediate split between *real-time* systems and *delayed-playback* systems. In a real-time system, the music program runs fast enough to send its computed waveforms directly to the conversion peripheral for immediate audio output. In a delayed-playback system, the computation results are saved on a mass-storage device for later high-speed playback, thus there is no speed constraint on the music program itself. Although a real-time system is obviously preferable, currently available computers are not fast enough to do everything that might be desired as accurately as desired in real-time. Thus a real-time software synthesis system involves numerous compromises.

Looking at real-time systems first we find very simple single-voice systems branching off first. Over the years some unusual conversion peripherals have been pressed into service including line printers, AM radios, and amplifiers connected to single output port bits. Simple timed-loop programming is all that is necessary to implement this type of system.

Along the multiple voice branch, which is necessary for any kind of chord structure in the music, we see that a single bit conversion device can be extended to 3 voices, each with a fixed pulse-like waveform. The software is now more complex because the effect of 3 simultaneous timed loops must be simulated. With some external filtering (which turns the pulse waves into sawtooth waves), sounds reminiscent of old-time reed organs can be obtained. Several years ago, Software Technology had such a system for S-100 machines and even earlier they could be found in the minicomputer software libraries.

To go further, it is necessary to use a more sophisticated conversion device. A *digital-to-analog converter* (DAC) typically utilizes all 8 bits of an output port to allow accurate waveform reconstruction, not just 2-level rectangular waves. The simplest DAC based music systems scan through waveform tables stored in memory to produce tones with literally any conceivable periodic waveform. As we will see later, multiple voice generation is much easier with a DAC so these systems can normally generate 3 or 4 voices simultaneously. Most of the popular small computers have a DAC based music system available as shown.

Basic waveform table scanning tends to produce mostly organ-like music but with a very wide variety of timbres or stops because any waveform may be used. This is due to the on-off (rectangular amplitude envelope) nature of the tone synthesis. Arbitrarily shaped envelopes require either high-speed multiplication (which most microprocessors lack), or software hardware tricks. One hardware approach is to add a programmable volume control to the DAC (thus making it a "multiplying" DAC). Normally one would then need one multiplying DAC per voice, but time-division multiplexing is possible, which allows one properly designed multiplying DAC to handle several voices with independent amplitude envelopes. Software techniques for fast multiplication abound but the most successful method simply involves scanning through dozens of waveform tables in sequence, each precomputed at a different amplitude level.

The final twig shown in this branch is the incorporation of "timbre envelopes". This is just another term for the "dynamically reprogrammable waveform" capability which essentially separated the professional from the amateur systems over on the hardware side of the tree. The same multiple waveform technique mentioned above is also applicable here and the results are generally quite good. Many conventional musical instruments can be simulated with a surprising degree of realism as well as many "way out" synthesizer effects. A moderate background noise level is the only defect keeping this type of system out of professional applications. Two systems incorporating the multiple waveform technique are currently on the market as shown. In the future this branch will be nurtured by faster microprocessors and continue to grow into dynamically variable pitch (for glides) and percussion instrument synthesis.

Delayed playback systems form the professional side of software synthesized computer music. Since program execution speed is no longer a constraint, literally any synthesis algorithm is admissible. In addition, more calculation precision, wider wordlength DAC's, and higher sample rates can all be used to suppress noise and widen frequency response for true high-fidelity output. The important branch here, and the one the author is currently involved in, uses floppy disks for sound storage. Full development of this branch will make professional quality music synthesis practical on personal computers with none of the limitations associated with hardware synthesizers.

Digital-to-Analog Conversion of Audio

The key to any kind of digital music synthesis beyond square waves is the ability to accurately convert from a numerical representation of sound waveforms to an analog representation through the use of a digital-to-analog converter. The best way to view the DAC is as a programmable power supply whose output voltage is determined by a binary number given to it as input. Whenever the computer changes the input number (which is typically held in an output port register), the output voltage immediately changes to the new value. Generating the electrical representation of a sound wave then is simply a matter of feeding a string of numbers to the DAC at high speed. Once in analog electrical form, an amplifier and speaker is all that is necessary to make the sound audible.

Like everything else in this world, there are inherent errors in the process. The most obvious one is that the DAC update rate, which will be called the *sample rate*, is finite. This means that the actual waveform generated by the DAC is a *stair-step approximation* of the desired audio waveform. Round-off error, which will be called *quantization error*, is less obvious and is caused by the DAC's finite word size although round-off in the synthesis calculations can also contribute.

A thorough analysis of the effect of these two errors could take up several pages and a lot of math so it will be summarized here. Typically the stair-step waveform from the DAC is smoothed by a *low-pass filter* before the signal is amplified and converted to sound. If the filter is perfect, the smoothing is also perfect. There is still a limitation as to the fastest waveform wiggle that may be reproduced, however. An up-down-up-down wiggle, which is two cycles of a high frequency waveform, will require at least four numbers or *samples* from the computer to specify. Any fewer than four

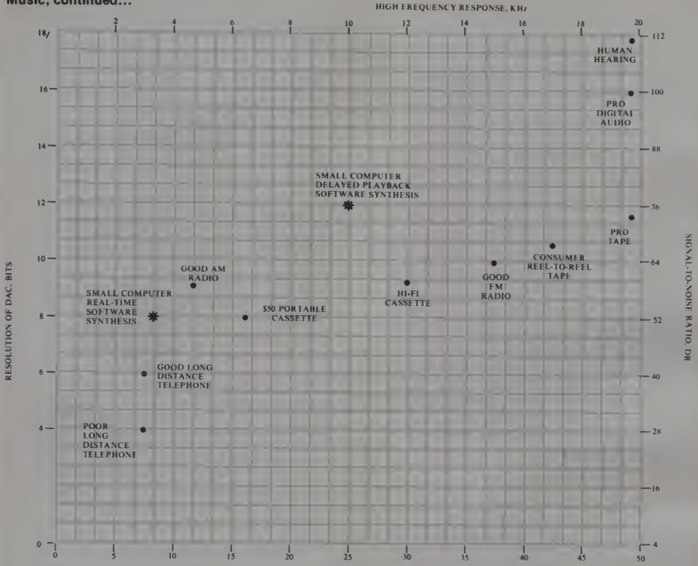

Figure 2. Audio Device Comparisons.

will cause the double wiggle to be severely distorted or glossed over entirely. Thus it follows that the sample rate must be at least twice as high as the highest audio frequency to be reproduced. If the low-pass filter is less than ideal, then the sample rate must be higher yet. With practical filters the sample rate must be about 2.5 times the highest audio frequency. It is interesting to note that there is no *low* frequency limit so bass down to DC may be reproduced without difficulty!

Round-off error on the other hand creates noise and distortion; thus, the more bits or digits of precision in the DAC and calculations, the less background noise there will be. Adding a single bit to the DAC will reduce the noise level by 6 decibels, a substantial but not dramatic difference. In decimal terms, adding a digit will reduce the noise by 20dB which *is* a dramatic difference. Audio DAC's used with personal computers nearly always have 8 bits of precision which gives an audible, but not always objectionable, background noise level.

The important point about these two error sources is that they degrade the sound *independently*. A finite sample rate *only* limits the high frequency response, it does not have any effect on noise or distortion. Conversely, round-off error has no effect on the frequency response.

Figure 2 should give the reader a feel for DAC performance compared to common audio devices. Since noise and frequency response are independent, a "performance plane" can be constructed with the vertical direction representing increasing freedom from noise and the horizontal direction representing increasing *high* frequency response. As mentioned before, low frequencies are no problem for DAC's. Be aware however that "sound quality" is very subjective and *is* greatly influenced by low frequency as well as high frequency response. Many devices listed have very poor low frequency response so when imagining how a device sounds, think only of adjectives like "clarity" or "brilliance" rather than "fullness" or "power". The points plotted are typical, they should really be diffuse ellipses to cover the often considerable spread in actual performance. The two stars represent the two computer music systems that will be discussed at the end of this article.

In order to approach these theoretical performance levels, it is necessary to use a quality DAC followed by a nearly ideal low-pass filter. Inaccurate components in the DAC circuitry (an 8 bit DAC needs component accuracy within 0.25% to approach its theoretical noise level) and an inadequate low-pass filter can seriously degrade the resulting sound. The simplistic DAC circuits that are published occasionally are fine for experimentation but should be replaced by a better unit for any serious work (or judgement of DAC synthesis quality).

Basic Synthesis Algorithms

Now that a suitable method exists for making the results of synthesis calculations audible with as little error as desired,

the focus shifts to the synthesis algorithms themselves. The ones that will be described here are equally applicable to both real-time and delayed playback systems. The algorithms will be illustrated through the use of program segments written in the Basic programming language so that they may be easily understood. However any practical software synthesis music program would certainly use machine language in the actual programming. Speed is doubly important in real-time systems since even a couple dozen *micro*seconds can make the difference between a 3 voice system and a 4 voice one or a half-octave difference in the high frequency response. Perhaps the best way to appreciate the difference in speed between machine language and Basic is to compare the examples with their machine language equivalents; the ratio is several hundred to one! Actually such a comparison is not very fair because the Basic program calculates to far greater accuracy than is required for an 8 bit result. Also, binary arithmetic overflow can often be used to advantage in machine language; in Basic, an extra statement is usually necessary to simulate the desirable effects of overflow.

Figure 3. Sawtooth Waveform Generator.

```
100 FOR I=1 TO D
200 R=R+F
300 IF R>=1 THEN R=R-1
400 POKE DA, INT(R*256)
500 NEXT I
600 RETURN
```

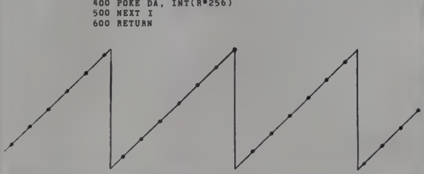

Figure 4. Triangle Waveform Generator.

```
100 FOR I=1 TO D
200 R=R+F
300 IF R>=1 THEN R=R-1
310 T=1.9999*ABS(R-.5)
400 POKE DA, INT(T*256)
500 NEXT I
600 RETURN
```

Before describing actual program examples, let's establish some variables that will be used. What we are looking for is a subroutine that will generate a tone of a specified frequency for a specified period of time before returning, i.e., a single note. It will be written for direct output to a DAC, that is, real-time but the final waveform *samples* could just as well be passed to a data storage subroutine instead, as in a delayed playback system.

Most of the parameter values are sensitive to the *sample rate* of the system. The sample rate must be *constant* throughout a software synthesis system to facilitate simultaneous tones and is usually chosen when the system is designed. In the examples, the sample rate will be called SR.

The *duration* parameter passed to the tone subroutine will simply be the number of samples to generate before returning. Thus if the sample rate is 10KHz and the tone must last ¼ of a second, the duration parameter will be 2500 which is the result of applying: (Duration parameter) = (Duration in seconds)*SR. In the examples, the duration parameter will be called D.

The *frequency* parameter specification may seem strange but it will simplify the tone generation routines considerably. With this method, the frequency parameter will be the *fraction* of a waveform cycle that a sample *period* represents. For example, if SR=10000 and the desired tone frequency is 1000Hz, then a sample period, which is 1/10,000 of a second, represents 1/10 of the tone waveform period which is 1/1,000 second. In equation form, (Frequency parameter) = (Tone frequency)/SR. In the examples, the frequency parameter will be called F.

The final variable will be the address of the DAC. The DAC will be assumed to be an 8 bit unit that accepts *offset binary* which means that -128 is represented as 0, 0 is represented as 128, and +127 is represented as 255. This is nice because it just happens to coincide with Basic's typical requirement that POKEd data be between 0 and 255. In the examples, the DAC's address will be called DA.

Simple Waveforms

Probably the simplest synthesis algorithm is one for directly computing *sawtooth* waveforms. Sawtooth waves have a full-bodied but somewhat buzzy timbre. Figure 3 shows the shape of a sawtooth waveform and the example Basic tone subroutine. The FOR loop of course controls how long the tone is generated according to D. The algorithm itself revolves around a variable called R. During each sample period, F is first added to R in statement 200. In statement 300, a check is made to determine if R has reached or exceeded unity or in other terms, *overflowed*. If so, one is subtracted from R, otherwise it is left alone. Assuming that F is fairly small, it can be seen that the repeated addition of F is responsible for the upward sloping ramp of the sawtooth and that the overflow is responsible for the sudden drop at the end of a cycle. Note that in general the tone frequency is not a submultiple of the sample rate. What this means is that the string of numbers sent to the DAC will differ from cycle-to-cycle. They will, however, always be points along an ideal sawtooth shape, so the intercycle variation *itself* is of no consequence.

Some study will reveal that regardless of the initial value of R, it will eventually be confined to the range of zero to one. Typically in a music system, all R's in the system will be initialized to zero before any music is played. In statement 400 R is simply multiplied by 256, truncated to an

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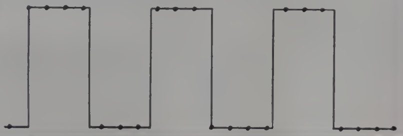
Figure 5. Square Waveform Generator.

```
100 FOR I=1 TO D
200 R=R+F
300 IF R>=1 THEN R=R-1
310 T=0
320 IF R>.5 THEN T=.9999
400 POKE DA, INT(T*256)
500 NEXT I
600 RETURN
```

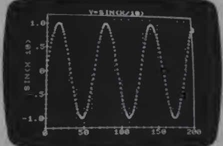


integer which will always be between 0 and 255 inclusive since R is never *equal* to one, and POKEd to the DAC's register. If the reader has machine language experience, it is apparent that these five Basic statements could typically be replaced by about five instructions. In such a machine language equivalent, R would simply be a machine register.

Figure 4 illustrates a modification that can be made to the sawtooth waveform generator to produce *triangle* waves. These have a mellow and somewhat hollow timbre that is pleasant to hear. Essentially only statement 310 need be added which flips the bottom half of the sawtooth shape up to produce the triangle shape. The multiplying factor in 310 would normally be 2 but then it would be possible for T to equal 1 and the POKE to fail. Using 1.99999 instead prevents this problem. In machine language, the problem would not arise so the multiplication by 2 could be performed with a single shift instruction.

Square waves can be produced with the program in Figure 5. Square waves have a very distinctive kazoo like sound. Statements 310 and 320 simply determine whether the sawtooth is in its lower or upper half-cycle and sets T to .99999 if it is the upper. The subroutine can be extended to *rectangular* waveforms by defining a variable S for the *symmetry factor* of the rectangular waveform. Then in statment 320, the comparison would be with S rather than the constant .5. Changing the symmetry has a fairly large effect on the timbre. A value of .25 for example gives a sound similar to a sawtooth while very small values give a thin buzzing sound. It is interesting to note that there is no audible difference between complementary values of S such as .2 and .8.

The program in Figure 6 is very interesting because it can produce a pure sine wave *without* using the trigonometric sine function in Basic. The timbre of sine waves is pure, sweet, and devoid of any color just like white sugar. Here it is important that R1 and R2 be initialized to reasonable values since the algorithm is not self-correcting like the previous ones were. Statement 200 computes an internal frequency parameter, F1, from the given F. Although a trig function is used in the F1 calculation, it is *outside* the tone generation loop. Both R1 and R2 represent the sine waveshape, the only difference is a phase shift of approximately 90 degrees. Also the conversion to DAC number format is slightly different than before because R1 and R2 vary between -1 and +1



rather than 0 and +1. This algorithm works best when F is .1 or less. If F is greater than .1, R2 should be initialized to a smaller value, such as .9, to avoid overflow in statement 600. The algorithm itself is simply the adaptation of a trigonometric identity to continuous sine wave generation.

Figure 6. Sine Waveform Generator.

```
100 R1=0: R2=.98
200 F1=2*SIN(3.14159*F)
300 FOR I=1 TO D
400 R1=R1+F1*R2
500 R2=R2-F1*R1
600 POKE DA, INT(R1*128+128)
700 NEXT I
800 RETURN
```

Simultaneous Tones

Although a variety of waveforms can be synthesized with the preceding subroutines, we are only about half way up the computer music tree since only one tone at a time can be generated. The amazing thing about software digital synthesis is that *any number* of simultaneous tones may be produced using the same DAC hardware. Of course more simultaneous tones means more compute time which *is* a problem in a real-time system but not in a delayed playback system.

The basic idea behind simultaneous tone generation is to compute a sample value for each tone during a sample period and then *add* all of the sample values together and give the *sum* to the DAC. This has the same effect as audio mixing except that any number of samples may be added up. The only problem is that the sum can *overflow* the DAC's range and create terrible distortion if care is not taken. Thus the sample values representing each voice must be *scaled* by an amplitude factor before being summed for output. The amplitude values may be different if it is desired that some tones be louder than others. Freedom from overflow is guaranteed if the sum of the amplitude values is less than unity. Strictly observing this rule however often results in a low *average* amplitude and thus a higher *relative* noise level in the final DAC output.

Figure 7 shows the Figure 3 tone subroutine modified for multiple voices. Now instead of a single frequency parameter, F, we have an F *array*. The same is true of R. An A array has been added which is the array of amplitude parameters. Finally the variable N is introduced which is the *number* of simultaneous voices to generate. Examination of the program reveals nothing more than an added inner loop to run through the N voices for each sample period. As can be seen, this new subroutine will be about a factor of N slower than the original subroutine. In a delayed playback system where time is not the dominant factor, the ultimate limit on N is the amount of memory available to hold the F, R, and A arrays. □

Figure 7. Multiple Sawtooth Waveform Generator.

```
 100 FOR I=1 TO D
 200 SM=0
 300 FOR J=1 TO N
 400 R(J)=R(J)+F(J)
 500 IF R(J)>=1 THEN R(J)=R(J)-1
 600 SM=SM+A(J)*R(J)
 700 NEXT J
 800 POKE DA, INT(SM*256)
 900 NEXT I
1000 RETURN
```

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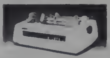

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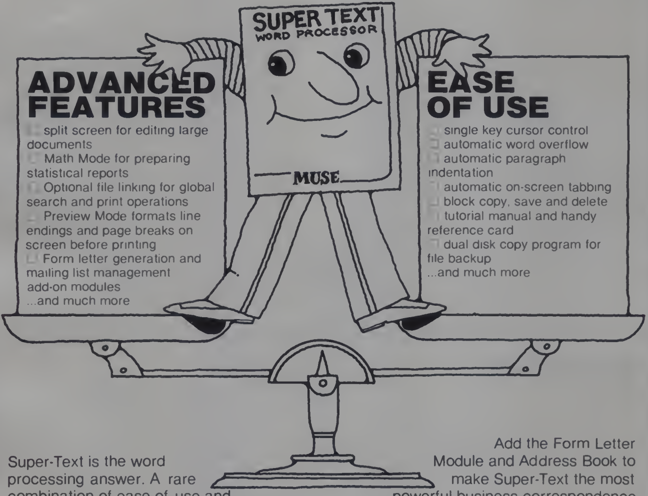

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Pictures by Funny Numbers

Frank Dietrich and Zsuzsa Molnar

What do pictures and numbers have in common? Nothing. Unless a computer is used to generate the pictures. Otherwise pictures and numbers live in two separate domains: the image being a concrete visual phenomenon, the number an abstract concept of order, counting or measuring.

Since computers deal quickly and efficiently with numbers, they can be used to calculate things like taxes and interest in a straightforward manner. Input is numeric anyway and if the right (not red) numbers appear as the output, the user is satisfied. In order to make images with this machine, one is forced to deal with numbers. Lots of them. The more efficient the computer, the more numbers it requires to be kept busy. Nice ways around this greedy demand for numbers have been developed in paint programs, in which the user draws with the old-fashion but flexible pen on a tablet. The computer picks up the appropriate numbers according to the position of the pen. Or, a TV image is digitized and the machine assigns the digital numbers.

In both cases, pen drawing and digitizing, we face again the question we started with: how are numbers and images related? Once an image is in the machine, it is sitting there in the form of numbers, waiting to be processed. We decided to investigate concepts of combinatorics, which have fascinated people since the first minutes of mathematics.

The three concepts illustrated here, Vedic and Latin Squares and Permutations, require minimal input, but generate a large variety of change and harmony, two extremly valuable principles in image-making. Implemented on a microcomputer graphics system, the ZGrass UV-1, these number games brought about interesting visual results we'd like to share. In its toolbox of graphic commands, ZGrass provides four basic primitives: POINT, LINE, BOX (filled rectangle) and CIRCLE (filled ellipse). All graphic commands need numerical information for the X and Y location as well as for the color option. Furthermore the width and height of boxes and circles has to be specified to turn bare numbers into visual beauty.

Frank Dietrich and Zsuzsa Molnar, Electronic Visualization Program, Dept. of Information Engineering, School of Art, University of Illinois at Chicago Circle, Box 4348, Chicago, IL 60680.

Vedic Squares

Our idea was to create pictures using sets of numbers which feature harmonic relations. The Vedic Square, a thousand-year-old number game, neatly fulfills these requirements. In the first row and column of a 9x9 square the numbers 1 through 9 are placed consecutively. All remaining numbers are computed by multiplying the values of the respective values of row by column. Each time the product exceeds 9, the number is reduced by forming the sum of the first and second digit, so that the Vedic Square contains only one-digit numbers. Astonishing patterns of numbers can be detected by further examining the square, now stored as a two-dimensional array.

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

Figure 2.

The drawing program scans through the rows and columns, relates them to an XY-grid and plots boxes or circles on the TV screen. The size and amount of the graphics depend on the current magic number called from the Vedic square, thus forming subtly symmetical images. (See Figure 1.) Since the righthand bottom lines of the square consist only of 9's, we decided to ignore them, leaving an 8x8 drawing square. (See Figure 2.)

Figure 1. Vedic Squares.

Funny Numbers, continued...

Magic Squares

To the Hindus these numbers revealed hidden secrets of life and time. The Arabs used Magic Squares to represent the astrological constellation of the stars. The numbers are arranged so that the sum of each row or column or diagonal is always the same. Three pictures based on a 4x4 Magic Square, the square of Jupiter, are shown in Figure 3. They are drawn with the method described above for the Vedic Square. In the second, the decision to draw a box or a circle depended on whether the Magic Number was even or odd. For the third image the center of the circles shifted to the right each time a smaller one was overlaid.

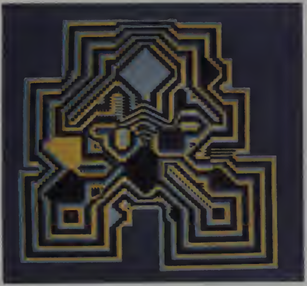
Other interesting types of squares are the Latin Squares. (See Figure 4.) These are NxN squares filled with numbers ranging from 1 to N in a way that each number is placed only once in a particular row or column. This feature guarantees an equal distribution of numbers, which is why Latin Squares are commonly used in statistics. An initial sequence of random numbers provides all the necessary information to compute the entire square. Once the square is computed and stored as a lookup table, its numbers are called by a drawing routine. This time the numbers specify four different graphic events: First, the size of the boxes and how many are drawn for each number. Even numbers direct the center of the boxes diagonally downwards, odd numbers direct them upwards. Finally, the color depends on whether a number is smaller, equal to or larger than the median of the set. As the images in Figure 3 demonstrate, each Latin Square forms different distributions of the graphic primitives, each exhibiting an internal harmony as well as a visible relation to all the other squares of the same set of numbers.

Permutations

The mathematics of permutation cycles a basic set of numbers through all of its possible variations. N enumerates the number of permutations or arrangements possible, where N defines the number of elements in the set, as well as setting the range of each individual element of the set from 0 to N. Here is the permutational path of a four element set:

0 0 0 0
0 0 0 1
0 0 0 2
0 0 0 3
0 0 1 0
0 0 1 1....until the 4 numbers produce 256 combinations.

Combining permutations with pictures, we can systematically explore how many pictures exist in one single composition. In the ZGrass language a complex user-built pattern can be defined by a high powered primitive, the SNAP. Once a SNAPped picture is given a name, it is



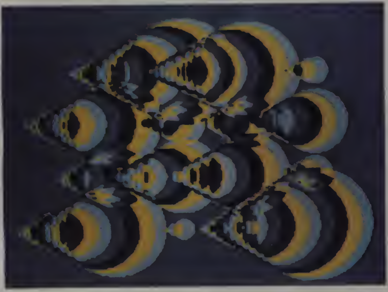


Figure 3. 4 by 4 Magic Squares.

Figure 4. Latin Squares.

These Latin Squares show the initial distribution of numbers to produce the graphic representation in Figure 4.

5 1 2 3 4	5 1 2 3 4
4 5 1 2 3	2 3 4 5 1
3 4 5 1 2	4 5 1 2 3
2 3 4 5 1	1 2 3 4 5
1 2 3 4 5	3 4 5 1 2

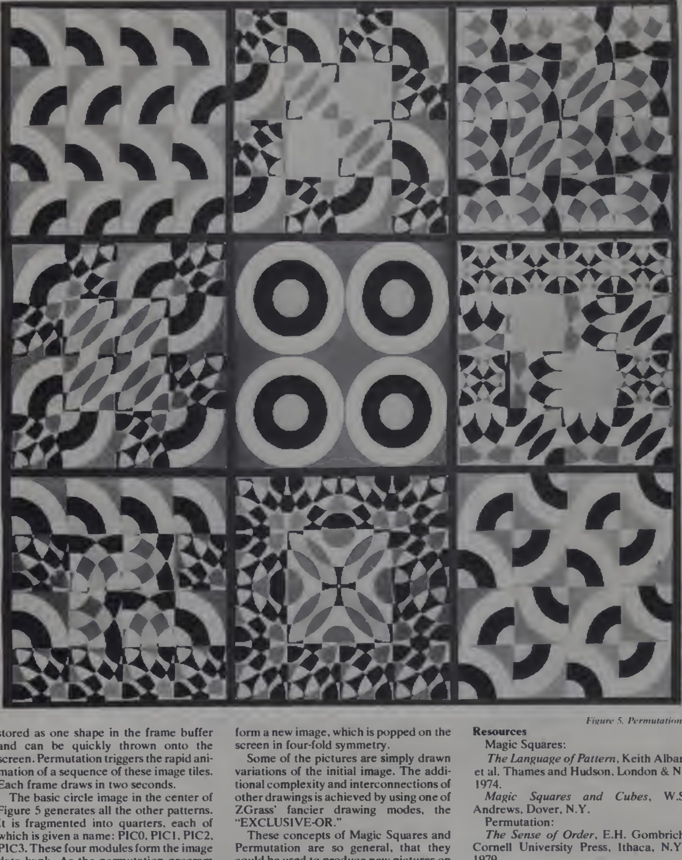


Figure 5. Permutations.

stored as one shape in the frame buffer and can be quickly thrown onto the screen. Permutation triggers the rapid animation of a sequence of these image tiles. Each frame draws in two seconds.

The basic circle image in the center of Figure 5 generates all the other patterns. It is fragmented into quarters, each of which is given a name: PIC0, PIC1, PIC2, PIC3. These four modules form the image data bank. As the permutation program cycles through the numerical variations, the permutation is applied to the name of the picture. Specified pictures are pulled out of the data bank and recombined to form a new image, which is popped on the screen in four-fold symmetry.

Some of the pictures are simply drawn variations of the initial image. The additional complexity and interconnections of other drawings is achieved by using one of ZGrass' fancier drawing modes, the "EXCLUSIVE-OR."

These concepts of Magic Squares and Permutation are so general, that they could be used to produce new pictures on any system. We look forward to getting feedback from readers who feel encouraged to give it a try, wandering off into other stimulating regions of Pixelland.

Resources

Magic Squares:

The Language of Pattern, Keith Albarn et al. Thames and Hudson, London & NY 1974.

Magic Squares and Cubes, W.S. Andrews, Dover, N.Y.

Permutation:

The Sense of Order, E.H. Gombrich, Cornell University Press, Ithaca, N.Y., 1979.

ZGrass:

"Language Control Structures for Easy Electronic Visualization," Tom DeFanti, *Byte*, Nov. 1980, Vol. 5, No. 11.

David R. Adams

This print, like all of my computer graphics, was coded by hand using printer spacing charts. Then a numeric code was assigned to represent each combination of shading character (1=⊕; 2=⊖; etc.) and the number then was keyed into a file. A short Fortran program translates the numbers to overprinted characters. This is more a problem of coding than programming.

David R. Adams, College of Business, Arkansas State University, AR 72467.

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Synergism: Artist & Computer

Joan R. Truckenbrod

The artist and the computer are a unique and unlikely pair. The linear, rational functions of the computer appear counter to the intuitive, free-flowing sensitivities of an artist.

Yet the delicate sensitivities inherent in my work, illustrated here, reflect the complementary character of the relationship between the artist and computer. Although opposite in nature, when integrated in the process of creating aesthetic visual imagery, the artist and this contemporatory media form a synergistic unit.

The synthesis of these polarities is an innovative, artistic process. The aesthetics of these color images reflects the synthesis of the logical processing of the computer with the intuitive aspects of the creative process.

These color images are experiments in creating ambiguous pattern systems by absorbing various foreground elements into the background. This interpenetration of foreground and background camouflages the real character of both the figure and ground elements.

The background is created by a series of color transitions in which one color gradually fades into another color to create an amorphous environment with soft edges. As one color fades into another color, a set of inbetween colors is created by the optical mixing of different color dots. These color changes create fuzzy edges and imply soft spaces.

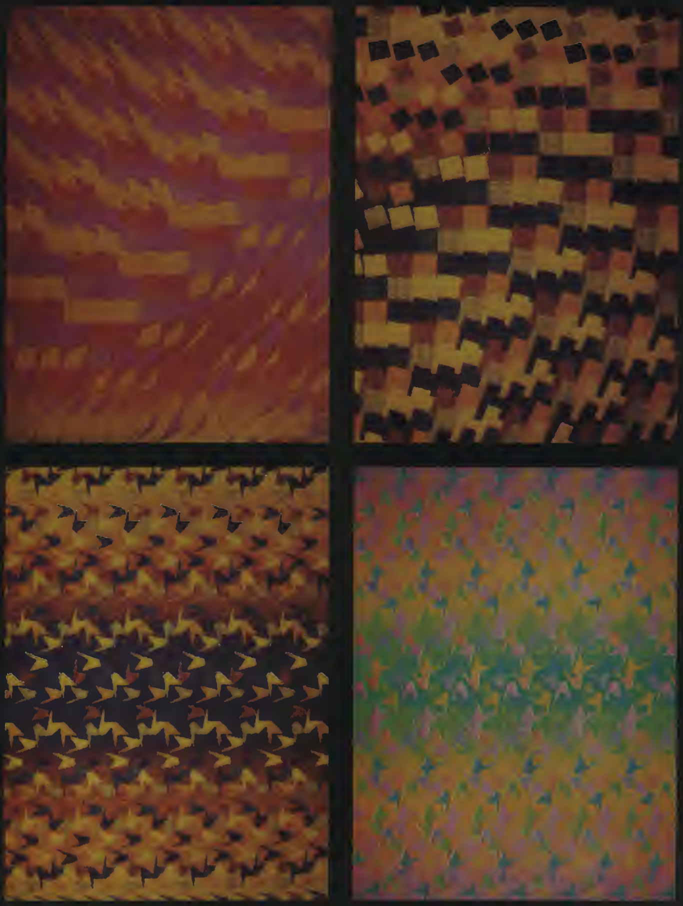
Next, a geometric pattern based on reflective symmetry is superimposed on this soft background to create an interesting contrast. This pattern is created in colors similar to the background and thus appears to fade in and out of space. This pattern becomes fluid as it floats through the background.

The images were created on a Tektronix 4027 Color Display Terminal with the aid of a Tektronix 4051 Microprocessor. The programs used to create the imagery were written in Basic by the artist. They are being transferred to large panels, 7' high and 10' wide with an ink-jet plotter to create elegant tapestries.

These new tapestries have a very special character, reflecting aesthetic innovative potential of contemporary media. Computer artists will play a major role in developing the creative potential of computing devices and will contribute a sense of aesthetics to the human interface with computing systems. □

Joan R. Truckenbrod, Department of Art, Northern Illinois University, DeKalb, IL 60115.

Computer Tapestries by Joan R. Truckenbrod



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CIRCLE 170 ON READER SERVICE CARD

In TRS-80 Basic...

Fast-Changing Screen Display

Michael Flanagan

When your Basic program uses the same display several times, you can waste a lot of time waiting for Basic's slow graphic routines to redraw the display. Here is a machine language subroutine that allows you to store your display in high memory on a 16K TRS-80 and almost instantly transfer it to the screen with a USR call.

There are two distinct methods available. You can use the Editor/Assembler, or you can POKE in the machine language from Basic. To use the Editor/Assembler:

1. Load EDITOR/ASSEMBLER.
2. Type in assembler program as in Listing 1.
3. Assemble program and create object tape.
4. Turn computer off then on again using 30975 for memory size.
5. Type SYSTEM and load the object tape.
6. Load the program to be modified and add subroutines 3 and 4.

To POKE the routine in from Basic:

1. Turn on the computer using 30975 for memory size.
2. Load the program to be modified and add subroutines 2, 3 and 4.

In either case subroutine 3 is executed just once, when the screen to be saved is visible on the monitor. The screen takes less than a minute to move, and once it's done, subroutine 4 may be called as often as necessary to redisplay that screen "instantly."

The first method assumes you have an editor/assembler, a desire to learn, and much patience. There is one advantage to offset the extra steps involved: this is the ability to make changes in the machine language subroutine.

The second method is faster, both initially and upon every loading of the program thereafter, as the object program does not have to be loaded from tape, since it is created by the Basic program itself (Listing 2).

With either method you must POKE 16526,0 and POKE 16527,121 before calling subroutine 4. This simply tells the computer where to branch to (in decimal) when it encounters the USR statement.

The subroutines are written for the TRS-80 Level II, 16K, and only work in a tape-based machine. For disk machines, you must relocate the routine to the top of 32K or 48K and use DEFUSR instead of POKE 16526,0 and POKE 16527,121. Other Z-80 machines can use similar block move routines, with the address changed and different patches to Basic. □

Listing 1.

```
100             ORG   7900H
110    VIDEO    EQU   3C00H
120    MAP      EQU   7A00H
130             LD    HL,MAP
140             LD    DE,VIDEO
150             LD    BC,400H
160             LDIR
170             RET
180             END
```

Listing 2.

```
1100  REM  CREATE MACHINE LANGUAGE
      SUBROUTINE
1110  POKE 30976,33: POKE 30977,0:
      POKE 30978,122: POKE 30979,1
     7
1120  POKE 30980,0: POKE 30981,60:
      POKE 30982,1: POKE 03983,0
1130  POKE 30984,4: POKE 30985,237
     : POKE 30986,176: POKE 30987,
     201
1140  RETURN
```

Listing 3.

```
1200 REM  SAVE SCREEN
1210 I1=15872
1220 FOR I=15360 TO 16383
1230 P= PEEK (I)
1240 POKE I+I1,P
1250 NEXT I
1260 RETURN
```

Listing 4.

```
>PR#0
>LIST
 1300 REM  REDRAW SAVED SCREEN
 1310 N=0:X=USR(N)
 1320 RETURN
```

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CIRCLE 164 ON READER SERVICE CARD

Atari Graphics Unveiled

Part 1

David and Sandy Small

There you are, seated in front of your new Atari. You know a little Basic, and would like to learn about making graphics displays—anything from the READY in blue letters now looking at you to the incredible animations of Star Raiders. You would like explained to you, in plain English, how on earth this box is making your TV set do these things. (You woefully recall asking a computer-whiz friend how it worked, and being deluged with words you'd never heard before or since: "Dee-Em-A," "rastering," "bandwidth," and worst of all, that mysterious god, "Exzorandnandnor," or Gate.)

"Surely," you say, "a degree in electronics and physics isn't needed to understand Atari graphics." And you are right.

It is the purpose of this article to explain the powerful graphics abilities of the Atari 400/800 without hopelessly confusing, boring, or annoying you. No high-level computerese or snob talk. No dry discussion of binary arithmetic. ("Thank heavens," I hear you say.) And there are examples you can punch directly into your Atari and run, understanding the graphics they generate. Only a limited knowledge of Basic is assumed. Along the way, we're going to learn things about the Atari that you can't find in your Basic manual—the inner secrets of Atari graphics. Only recently has this information become available, so don't be surprised if one day, you amaze your friends, and leave *them* looking blank, with what you've learned.

So, let's get to it.

How a TV Works

In order to understand how the Atari does its work, we need to touch on how a TV set works inside. (If you already know all about raster scan and don't need a review, skip this part). Go turn on a TV and look at it closely. You'll see many horizontal lines, packed very closely together. Any picture you see on TV is made up solely of those lines; let's find out how.

Inside the TV picture tube you're looking at, painted on the inside surface, is a substance called phosphor. Phospor has an interesting property; when an electron hits it, the place where the electron hit glows briefly. (A meteorite hitting the atmosphere glows briefly also; an electron by itself, like a meteor without an atmosphere, doesn't glow.) Now inside the picture tube there is a device for shooting out electronics, called an electron gun. It fires electrons at the screen in a very accurate path. The way the gun is aimed at the phosphor is shown in Figure 1. When the electron gun fires, an electron leaves it, travels to the screen, hits the phosphor, and the phosphor glows briefly. Since the electron gun fires a steady stream of electrons, the spot where the electron gun is aimed glows continuously, while the gun is firing. The picture on your TV is composed of glowing phosphor dots.

At this point, we have an electron gun firing continuously onto the phosphor of the screen. The TV picture shows one brightly glowing dot in an otherwise dark screen. If you'll enter Program 1, and run it, you'll get a good idea what this looks like.

```
5 REM PROGRAM 1
10 GRAPHICS 8+16
20 SETCOLOR 2,0,0
30 SETCOLOR 1,0,14
40 COLOR 1
50 PLOT 160,92
60 GOTO 60
```

Listing 1.

In order to draw graphics on the screen, more than one dot must be energized by the beam of electrons. This is done with charged "deflection plates," which bend the beam, causing the position of the dot to move onscreen. When the dot is moved

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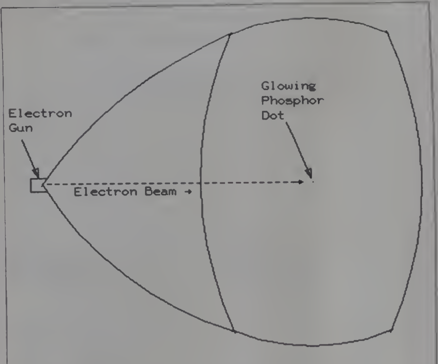

Figure 1.

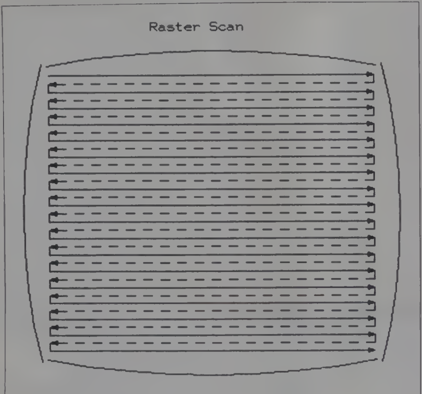

Figure 2.

from one point to another, a line appears on the screen; this is because the beam of electrons lights all the dots between the two points on its way. These individual lighted dots appear to be a line because they are so close together. Enter and run Program 2 to get a drawn line on the screen; if you have a very sharp picture, you may be able to see individual dots.

```
5 REM PROGRAM 2
10 GRAPHICS 8+16
20 SETCOLOR 2,0,0
30 SETCOLOR 1,0,14
40 COLOR 1
50 PLOT 1,96
60 DRAWTO 319,96
70 GOTO 70
```

Listing 2.

However, if we trace the line just once, it will stop glowing quickly because when the electrons stop hitting the phosphor, it stops giving off light. In order to display a line that glows steadily, the beam of electrons has to hit every dot in it over 30 times a second. At that speed, or faster, the phosphor doesn't have time to fade out before the beam energizes it again. If the line is not retraced, or "refreshed," 30 or more times per second, it will start to flicker.

Any steady image you see on a TV screen is being continuously refreshed; the most common refresh rate is 60 times per second. If this refreshing process stops, the TV screen goes blank. Television stations send information continuously to the TV, even when the screen is "frozen" (during a test pattern, for instance). An Atari sends continuous signals that mean "READY" to the TV, 60 times per second, when the TV displays "READY" (as right after you switch it on).

In a TV set, the electron beam is moved in a standard pattern, by deflection plates. It starts at the top left and travels down to the lower right, scanning back and forth across the screen. (See Figure 2.) The beam traces hundreds of horizontal lines across the screen. This is called a "raster scan," and the lines are called "scan lines."

While the beam is being traced in the fixed path, the intensity of the electron gun is varied. Now when electrons hit the screen, the phosphor glows more brightly, and vice versa. By varying the intensity of the beam as it scans across the screen, the screen will show shades of grey.

Let's review what we've covered so far; we'll need it later when we discuss some of the more sophisticated features of the Atari. The phosphor is painted on the inside of the picture tube. Electrons fired from an electron gun cause it to glow. The number of electrons the gun fires determines the brightness of the glowing phos-

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CIRCLE 263 ON READER SERVICE CARD

phor and allows shades of grey. Finally, the TV traces the beam in a horizontal pattern, left to right, one line at a time, from the top to the bottom of the screen. At the end of the screen, the gun starts all over again at the top.

Well, you ask, "What about color? How does that work?" Color isn't very different from black and white in terms of how it is generated. Instead of a phosphor that glows only shades of grey, the screen is split up into very small dots. Inside of each dot is a place that when hit with a beam of electrons will glow one of several colors. (See Figure 3.) The gun is aimed very precisely at these sub-dots, so that when it is signalled, for example, to show a blue dot at a particular point on the screen, it hits the blue "sub-point" that causes that dot to glow blue. Note that now there is a limited number of dots onscreen, because each color must be represented, packed in next to each other. No dot is located next to another dot of the same color; for example, two blue dots could not be lit, one right next to the other. Every dot fixed in one position, so they cannot be moved. The Atari knows the positions of all the color dots, and draws graphics using them.

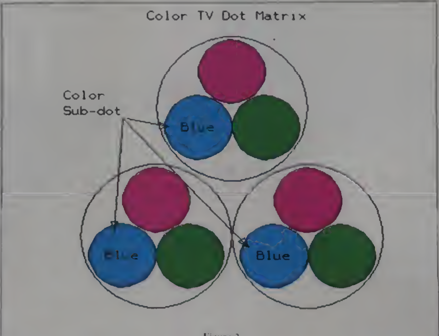

Figure 3.

All any TV transmitter does is synchronize with the TV and then send it a continuing stream of color and brightness, or luminance, information. The TV handles scanning back and forth and putting the information coming to it onscreen at the right color/luminance. (I'll refer to color and luminance information as color/lum from now on.) The TV station doesn't specify to the TV just where a given color/lum should be displayed; rather, it sends that information at the time when the TV scan will have reached the proper point. The Atari works in the same manner.

An Atari needing to plot a dot at a particular point can't directly tell the TV to "put it here," and give it X and Y coordinates. Instead, it has to wait until the electron beam has reached those coordinates in its top to bottom scan, then send the TV color/lum information for that dot. Incidentally, the Atari must immediately send information for the next dot over too, and if the one dot is meant to stand out (as in our example), the next dot over must be dark, as set by its color/lum information. Remember that the Atari must do all this sixty times per second to keep a steady TV picture onscreen.

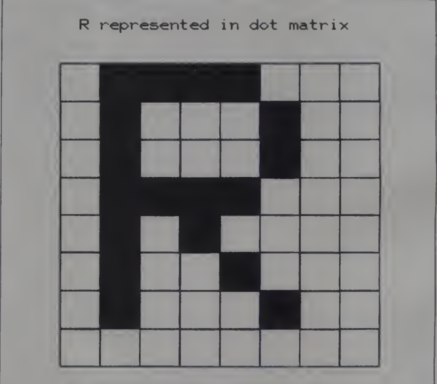

Figure 4.

Since the Atari conforms to TV standards, it must display everything with horizontal lines composed of individual dots. This includes lines and characters; all must be composed of these dots at a certain color and certain intensity. Let's examine how the Atari does it for characters.

Character Generation

When you turn on your Atari, the work "READY" appears. We know that the letters of "READY" have to be made out of dots of various color/lum. Let's find out how the computer does this.

Look at Figure 4. Here we have an "R" with a grid on top of it. Wherever in that

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Triangle as character

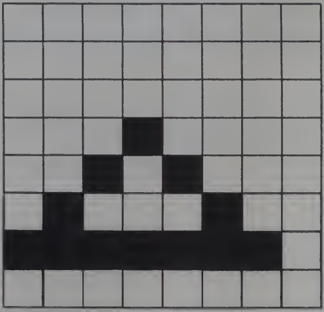


Figure 5.

grid "R" crosses a square, the square is filled in. Thus we get a rough "R" from the shape of the squares. These squares can be thought of as dots. If we send the TV this dot pattern, line by line, by having it turn on the fill-in dots and leave the others off, an "R" will appear onscreen. Since we've broken the "R" up into eight horizontal segments, the "R" on the TV screen will be eight scan lines high.

"READY" is just a bit more difficult. We must first send the top "slice" of "R," then of "E," then of "A," "D," "Y," then finish out the scan line, then do the next slice down on "R," and so forth. After eight scan lines are done, we'll have our "READY" on the TV screen. Remember we have no choice about what order the lines are plotted in (top to bottom, left to right).

We can display any character we want, or any shape, through these methods. If we wanted to display a triangle onscreen, we'd split it up into eight horizontal segments, each composed of dots, and send that. (See Figure 5.)

Go switch on your Atari and examine the "READY" characters. You'll be able to see the scan lines and individual dots—provided the picture isn't too fuzzy.

Remember that the Atari must refresh the TV image 60 times per second, or the dots will stop glowing and fade away. In order to regenerate the image, it must be stored, in some form, inside the Atari. To find out how the Atari stores this image, we'll have to examine (briefly) some concepts of computer memory.

When you turn on your Atari, the word "READY" appears. Let's find out how the computer does this.

Your Atari is equipped with computer memory organized in "bytes." One "byte" is composed of eight "bits." A given amount of computer memory is generally referred to as a certain number of "bytes"; for example, a "48K Apple" is an Apple machine equipped with about 48,000 bytes of memory. (The K refers to "thousand.") Your Atari has a variable amount of memory, depending on how much you buy for it. (Maximum is three 16K memory expansions or 48K; the Atari has limits in its design which prevent it from using any more.)

A "byte" can represent any number—integer—from 0 to 255. It does this by using unique combinations of the eight "bits" to represent the number. A bit, of which a byte is made up, can represent only a 0 or a 1. Further explanations of this can be found in any discussion of binary arithmetic, and we'll be going into it in a bit more detail soon. However, it isn't necessary for right now to know anything more than this: a byte can be any integer from 0 to 255, and a bit, from which bytes are constructed, can be 0 or 1.

Let's see how this can be used. Our Atari is trying to represent the letter "R" in its memory. It thinks of the "R" as a group of on or off dots. This corresponds nicely to the concept of a "bit"; a 0 can be thought of as an unlit dot and a 1 as a lit dot. Let's go back to our figure of the "R" broken up into dots, and represent it as bits instead. (See Figure 6.)

It takes eight bytes, each composed of eight bits, to store our "R" in the memory of the Atari. When refresh time comes for the "R," it takes the first byte, and sends it to the TV as a blank dot for each 0 bit, and a bright dot for each 1 bit. After completing the rest of the scan line, it does the second byte, or row, of the "R." After eight scan lines are done, the "R" is fin-

R as dot-matrix and bit patterns

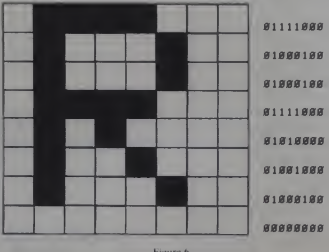


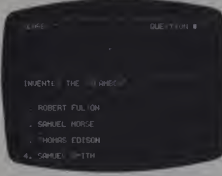
Figure 6.

Atari sensational software

creative computing software

Trivia Unlimited

Cassette CS-7001 $11.95 — Requires 24K



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Outdoor Games

Cassette CS-7002 11.95 — 4 Programs — Cassette CS-7002 (32K) $11.95

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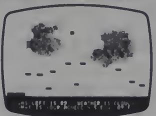
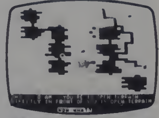


Fishing Trip. Try to catch flounder and salmon while avoiding logs, sharks, bad weather and running out of fuel.

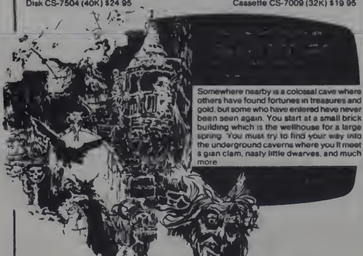


Treasure Island I. Your map shows buried treasure but unfortunately you don't know where you are. Try to find the treasure while moving about and observing your surroundings. You have a 3-day supply of food and water. You may find useful objects (compass, weapons, a horse) but watch out for hazards (robot guards, pirates, caves, crocodiles, mountain lions and more).

Treasure Island II. Same game except you have to use a metal detector to find the treasure.

Original Adventure

Disk CS-7504 (40K) $24.95 — Cassette CS-7009 (32K) $19.95

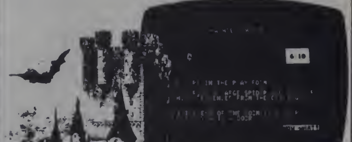


Somewhere nearby is a colossal cave where others have found fortunes in treasures and gold, but some who have entered have never been seen again. You start at a small brick building which is the wellhouse for a large spring. You must try to find your way into the underground caverns where you'll meet a giant clam, nasty little dwarves, and much more.

Available 7/81

Haunted House

Cassette CS-7003 $11.95 Requires 32K



It's 6:00 pm and you have until midnight to find the secret passageway out of a large rambling HAUNTED HOUSE. During your search you'll encounter skeleton keys, charms, friendly ghosts, and evil spirits. Sound effects add to the eerieness. The layout changes in every game.

Trivia Unlimited

Disk CS-7501 (16K) $19.95

This is a menu driven version of CS-7001

Hail to the Chief

Disk CS-7701 (40K) $24.95
Cassette CS-7201 (32K) $24.95

This comprehensive election simulation is described completely in the Apple software section

Outdoor Games & Haunted House

Disk CS-7502 (40K) $19.95

This disk contains all five programs from cassettes CS-7002 and CS-7003.

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creative computing software

ished. Of course, the "READY" must also be represented, so each letter has an eight-byte chunk of memory assigned to it.

Hence, if the Atari used this approach, we'd need eight bytes for each character onscreen. There are 40 characters per line and 24 lines (960 characters), so this comes out to a memory requirement of 7,680 bytes.

In order to clear up any confusion at this point, let's construct an analogy. Imagine a chessboard with 40 squares across and 24 down. On each square we put one letter. This is the Atari's "display memory." When the Atari needs to refresh the screen, it starts at the top left corner of the board, finds an "R," put it onscreen, then "E," and so forth. (Remember that it must do this in slices). Each square thus corresponds to one character displayed on the Atari. Since we're saving the shape of each character in the square, we need eight bytes of memory per square. (See Figure 7.) You can consider the chessboard as stored in memory a row at a time, in one long line.

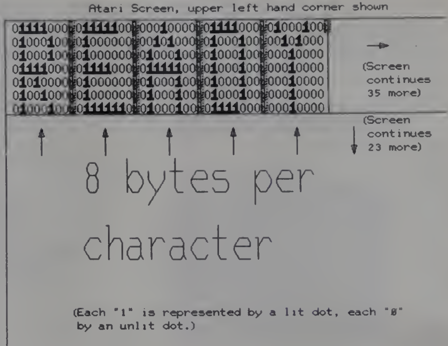

Figure 7.

This approach to display memory is called "bit mapping." The name refers to the fact that every bit in display memory corresponds to a dot onscreen—one-to-one. (The "bit" is "mapped" onto the screen.) It gives you the ability to control any dot on the TV individually. There's just one problem with it, and that's the amount of memory required to do it.

Memory is a scarce commodity in a computer. The cost of 16,000 bytes for your Atari is $200 (retail). Dedicating over 8,000 bytes of it to display—one sixth of your total memory if you've spent the money to get the maximum amount—isn't very good. That memory is needed for other purposes, like storing your Basic programs. Let's find a way to use less memory. (Incidentally, in case you're wondering, the memory is physically located in those cartridges that plug into the top of the Atari, with "8K" or "16K" written on them.)

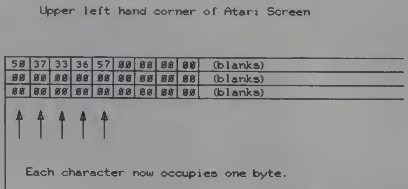

Figure 8.

Remember that in our chessbord (memory), we are saving the shape of every letter on screen. What we could do is define the shape just once for each letter, then in our display memory just tell the Atari where to look for the shape of each character.

To clarify this, let's go back to our analogy. Our "chessboard" right now has eight bytes in each square defining the shape of each character with bits. Instead of eight bytes, let's assign just one. A byte, you'll recall, can hold a number from 0 to 255. Next, for each character or shape we would ever want to display onscreen, we'll assign a number from 0 to 255. Atari does it like this: A is 33, B is 34, and so forth. (for "READY"; 50,37,33,36,57). Other characters, such as commas or asterisks, have their own numbers.

Somewhere in memory we put a complete table of character shapes, eight bytes per character, just as we did before. Given a number—for instance, 33—the Atari can determine its shape from this table ("A"). From this shape it can then display the letter.

Now our 40 x 24 chessboard has just numbers on it. In the upper left hand corner, the first five numbers are: 50,37,33, 36,57. (See Figure 8.) The Atari knows these numbers to be "READY," via its shape-table, and can through them generate the display. Let's calculate the memory we've used now: 1 byte per character, 40 x 24 screen = 960 characters or 960

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- Printer test
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SYSTEM REQUIREMENTS

- Apple*][plus with auto start ROM
- 48K of memory
- Two 5¼" Disk Drives
- DOS 3.3
- Video Monitor.
- Printer (optional)

DOCUMENTATION:

The final word is Documentation We at Maromaty & Scotto know that even the most brilliantly conceived program is useless if you can't understand it. That's why easy to understand material is the distinction between what is merely a good package and a truly excellent one

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	C.O.R.P.™ Manual Only	$ 5.00

($5.00 credit towards system when ordering manual only.)

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CIRCLE 196 ON READER SERVICE CARD

bytes. This is one eighth of what we were using before, and this is the technique the Atari uses to store characters. The first 40 bytes of display memory are used to store the first row, the second 40 the second row, and so forth. I should also make clear the point that display memory is a section of regular memory, located anywhere, and is physically the same as regular memory; its function is all that makes it display memory, just as the memory assigned to storing Basic programs is program memory. It's all in the same chips, and what physical memory is asigned to what function varies a lot.

In summary, let's go through the whole process of displaying a "READY." The Atari determines that it's time for a screen refresh. It starts with the uppermost slice of the first character on the upper left-hand corner. It looks to the display memory chessboard, and finds a 50 there. It says "50," to itself. It looks up a 50 in its collection of character shapes, and finds the shape "R." It outputs to the TV the top segment of "R," composed of eight on-off dots from the top slice of the "R" shape (first byte). The TV gets this information, composed of a group of color/lum information, when it is displaying the first eight dots, and displays them. The Atari then gets the 37, which it outputs as an "E" (top slice only), and so forth for the first scan line. Next, it sets the second byte of the "R," sends that slice, then of the "E," "A," "D," and "Y," with the remainder of the scan line. It repeats this process eight times, at which point the display of the first row of 40 characters, which are eight scan line high, is finished. It repeats this process 24 times for the entire screen. This whole process is completed 60 times a second (See Figure 9.)

The Atari uses its display memory in two different ways: either "character addressing," where we reserve one byte per character, or "bit mapping," where we reserve one bit per each screen dot.

Next, let's find out how the Atari handles lines.

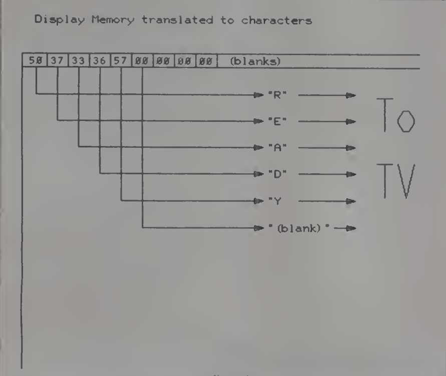


Figure 9.

Lines

Surprise! You already know how lines work. Remember our discussion of "bit mapped" memory? That's how lines are done on the Atari. We have one bit for each dot onscreen, and if that bit is on, the Atari has the corresponding TV dot switched on each pass. Yes, this uses a great deal of memory. Look in the back cover of your Atari Basic manual. There it notes the amount of memory ("Random Access Memory," or RAM) required for each Graphics mode. Under Graphics 8 mode, it says 7900 bytes. This compares with our calculated figure of 7,680 bytes. (The differences we can attribute to various tables and other data the Atari keeps around in this mode.)

Also examine the number of displayable dots in the X and Y directions for Graphics 8: 320 x 192. Now 320 is 40 (characters) x 8 (bits per character shape horizontally), and 192 is 24 (rows) x 8 (scan lines per character). See? You now have a pretty clear picture of what's going on inside the machine. Just eliminate the character squares on our chessboard, and we'll have 340 x 192 dots, each one represented by one bit inside the Atari (the bits happen to be part of bytes), and you have a representation of how the Atari handles Graphics. In this mode, the first 320 bits of display memory (40 bytes) are the first scan line, the second 40 bytes the second scan line, and so on.

How does the Atari display a line? By turning on the dots onscreen that the line "passes over." Run Program 3, and you'll be able to see the individual dots lit up, as well as how the dots shift over a discrete horizontal amount when they're diagonal.

```
5 REM PROGRAM 3
10 GRAPHICS 8+16
20 SETCOLOR 2,0,0
30 SETCOLOR 1,0,14
40 COLOR 1
50 PLOT 1,1
60 DRAWTO 319,1
70 DRAWTO 1,191
80 DRAWTO 1,1
90 GOTO 90
```

Listing 3.

The Atari uses its display memory in two different ways: either "character address," where we reserve one byte per character, or "bit mapping," where we reserve one bit per each screen dot. The statistics as listed for character addressing, also known as Graphics 0, are 40 x 24 characters, 993 bytes used (we calculated 960; again, table space adds to the space needs), and for Graphics 8, 320 x 192, with 7900 bytes used. Now rather than just limit the user to two Graphics modes, the Atari people gave Basic programmers nine, numbered 0 to 8.

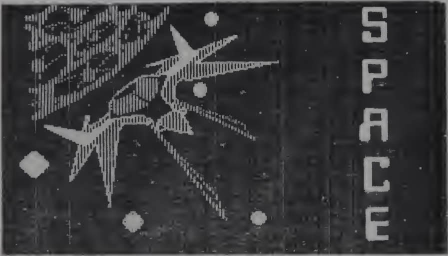
Look in the back of your manual again. The Atari has nine Graphics modes which you may access through the BASIC GRAPHICS statement. Graphics 0 is regular character mode. One and 2 are like 0, but the characters are displayed in expanded form, i.e., stretched horizontally and/or vertically. This results in fewer characters per line, and since we're still character addressing, various combinations of the number of usable X,Y points and the number of colors they can be displayed in (remembering what color a given point is takes more memory; the more colors, the more memory is required). In Graphics 3-7, memory represents not a single dot but a whole group of dots. In other words, every screen dot in that group will have the same color and lum, but the whole group is represented by one memory location. The higher the Graphics mode, the smaller the number of screen dots per group, and the finer the resolution and quality displays possible. Finally in Graphics 8, we have one screen dot per memory bit, and only one color. It takes a lot of memory, as the table shows.

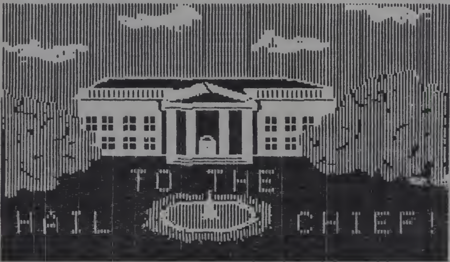
The Atari manual states that only one graphics mode can be used at a time—sometimes with a Graphics 0 "window" at the bottom of the screen. When you consider how display memory is organized, this is very reasonable. If we have a character display going, and suddenly decide to switch to Graphics 8, the Atari will start to display the numbers we saved for Graphics 0 as Graphics 8 bit-dot patterns.

For example, if we look at the top left hand corner of the screen (where the "R" is on startup), we would find the first location has a 50 in it. This is our "R." In Graphics mode 0, this is displayed as an "R" eight scan lines high. But, in Graphics 8, this data would be represented by a bit pattern of 0,0,1,1,0,0,1,0. A dot would be lit for each 1, and there would be a dark pattern for each 0. We'd have a random dot pattern on the screen where the "R" used to be, and it would be only one scan line high. Remember, when we use the data in display memory differently, for the different Graphics types, we have to be consistent. There's one other problem. If we switch from Graphics 0 to Graphics 8, our display memory needs are going to go from 993 to 7900. That memory must come from the top of the regular display memory. Unless this memory is zeroes, we'll get dots all over the screen as the bit patterns are represented as Graphics 8 dots.

You can begin to see all these graphics modes can bring problems. The Atari people adopted the sensible strategy of not having people call in to complain about incomprehensible manuals and random dots all over their screens when their programs didn't work right, and told their customers nothing besides the fairly foolproof Basic graphics statements. The really good graphics capabilities they left to their engineers, and that's what we're going to explore next month in the second part of this article. □

Apple Picture Packer





David Lubar

An Apple disk has a lot of space available, until you start saving hi-res pictures. Suddenly, 100K becomes very small. At best, you can store 12 pictures, along with a short program to display them. DOS 3.3 provides a bit more space, but still limits picture storage. Rather than look for more storage room, it seemed logical to try cramming the picture data into a smaller package.

While I had heard rumors that the Wizard of Cupertino knew how to fit more pictures on a disk, I'd never come across a program for doing this. I decided to give it a try. The task turned into something between an addiction and an obsession. I was never satisfied; each time I managed to reduce storage, I needed another sector—just one more, then I'd quit. And so it went for three weekends. I produced one revision after another, ending with Picture Packer 3.0. While there is still room for improvement, I believe the existing version is useful and worth sharing with the Apple community.

The program could have been written in Basic, but it would have been way too slow for any real-time application. Enter machine language—a bit tougher to write and debug, but a lot faster. My goal was to make a table that would contain 8K of hi-res data in less than 8K of space. Most pictures contain a fair amount of repetition. A look at screen memory (from $2000 to $3FFF for page one of hi-res graphics) will reveal that pictures tend to contain long strings of identical bytes.

Rather than store a series such as 00 00 00 00 44 77 00 00 00, it seemed reasonable to expect a saving of space by storing a table which said, "There are four zeroes, a 44, a 77, then three more zeroes." Using this approach, Picture Packer 1.0 was born. It made a table from screen memory. The table was composed of pairs of bytes; the first byte told how many times in a row the second byte appeared on the screen. In essence, the first byte gave the frequency of the second. For example, starting with a series of screen bytes such as 00 00 00 00 AA AA AA FF 00 00, the table would contain 04 00 03 AA 01 FF 02 00.

A test version was written to pack the lo-res screen. If it worked, the change for hi-res would be simple. The program packed a lo-res picture of 1K into a total of less than 3/4K. Feeling confident, I changed the pointers and tried packing

The pictures to the left were all scrunched with Picture Packer. The space scene required 14 sectors, "Adventure" took a mere 10 sectors, and "Hail to the Chief" required 19 sectors.

sensational software

Apple II

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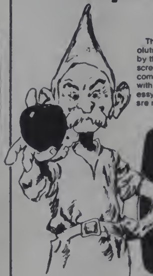
Haunted House

Cassette CS-4005
$11.95
Requires 16K

It's 6:00 pm and you have until midnight to find the secret passageway out of a large rambling HAUNTED HOUSE. During your search you'll encounter skeleton keys, charms, friendly ghosts, and evil spirits. Sound effects add to the eerieness. The layout changes in every game.

Super Invasion

Cassette CS-4006 $19.95
Requires 16K Apple II or Apple II Plus

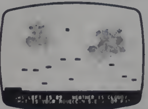


This original invasion game features superb high resolution graphics, nail biting tension and hilarious antics by the moon creatures. Fifty-five aliens whiz across the screen, quickening their descent, challenging you to come out from behind your blockades and pick them off with your lasers. A self-running "attract mode" makes it easy to learn and demonstrate the game. Game paddles are required.

Outdoor Games

Cassette CS-4010 $14.95 4 Programs Requires 16K Apple II or Apple II Plus

Forest Fire. Use chemical retardants and backfires to control raging forest fires.



Fishing Trip. Try to catch flounder and salmon while avoiding logs, sharks, bad weather and running out of fuel.

Treasure Island I. Your map shows buried treasure but unfortunately you don't know where you are. Try to find the treasure while moving about and observing your surroundings. You have a 3-day supply of food and water. You may find useful objects (compass, weapons, a horse) but watch out for hazards (robot guards, pirates, caves, crocodiles, mountain lions and more).

Treasure Island II. Same game except you have to use a metal detector to find the treasure.

Space War

Cassette CS-4009 $14.95
Requires 16K
Apple II or Apple II Plus

Take command in Space War. Select from five game modes, including reverse gravity, and the battle begins. Challenge your opponent with missle fire, force him to collide with the sun or to explode upon re-entry from hyperspace. Be wary. He may circle out of sight and re-appear on the opposite side of the galaxy. (This is the classic MIT game redesigned especially for the Apple.)

Outdoor Games and Haunted House

Disk 4504, $24.95
Requires 32K Apple II or Apple II Plus

This disk contains all five programs from cassettes CS-4005 and CS-4010

Super Invasion Space War

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the hi-res screen. The first picture I tested was reduced from 32 sectors (8K requires 32 disk sectors—each disk sector contains 1/4K) down to 22 sectors. I was beginning to feel the thrill of victory when Murphy's law took effect. The next picture went from 32 sectors to 48—not exactly an economical conversion. Looking through the table and the hi-res screen, I noticed a lot of single bytes that didn't have the decency to repeat themselves and make life simple for me. The table saved space whenever there were strings of repeated bytes, but each unique byte required two bytes in the table. For example, the series 00 FF AA 38 would be packed (?) into a table as 01 00 01 FF 01 AA 01 38. Obviously, a slight change in strategy was required.

Looking at screen memory again, I noticed that there were patterns in most pictures. Some had long strings of identical bytes, others contained pairs of bytes such as AA 55 AA 55, while others had groups of four such as 38 FF AA 72 38 FF aa 72. I converted the program, making it go through the screen twice. On the first pass, it packed bytes 1,3,5 ...; on the second pass, it took care of 2,4,6 .... A series such as AA 55 AA 55 AA 55 would be represented by a table that started with 03 AA, followed by the rest of the first pass. The second pass would start with 03 55. This method succeeded in crunching pictures containing a large number of duplicate pairs.

I was faced with the unpleasant prospect of using different programs for different pictures. But there was a way around this non-utile aspect of the utility. Picture Packer 2.0 made three test packings of the screen. First, it constructed a table made by taking the bytes in order. After saving the length of this table, it did the packing in two passes, taking every second byte, then in four passes, taking every fourth byte. It compared the three table lengths and selected the method which produced the shortest table. This shortest version was repeated, and a byte was placed at the beginning of the table, telling how many passes were made. The unpacking program could use this first byte to tell what kind of table it was working with. The identification byte also served as the offset when stepping through the screen.

This version of the program produced a substantial improvement over the first version. Unfortunately, while some pictures were now being scrunched into as few as 16 sectors, others were still taking up more than 32 sectors. Looking through the table, I found the culprits were the single bytes. Each unique byte required two bytes in the table, and a series of unique bytes really killed any attempts at economy. It was time for a major change in strategy.

There had to be a way to reduce the space taken when storing a long series of unique bytes. Somehow, I had to put even more information in the table while using less space. I decided that instead of representing a series such as AA FF 35 7F as 01 AA 01 FF 01 35 01 7F, I could strip out all the 01's by using a signal byte such as FF, where FF NN would mean that the next NN bytes were unique. Had hindsight been working properly at the time, I would have seen the problem with this approach. However, logic tends to get a bit loose late at night, and I gave the method a try. The results were dismal. At times, I was using three bytes to represent a unique byte. It was rethink time again.

Suddenly, certain pictures were turning into garbage when they were unpacked.

There were two possibilities that needed to be distinguished in the table; either a screen byte was repeated or it was unique. This information didn't require a whole byte—it could be contained in a single bit. At the moment, each frequency byte was in a range from 1 to 256 ($00 to $FF with $00 representing 256 decimal). By reducing the range to a maximum of 128, the high bit would be free. I decided to use the following convention: if the high bit was 0, the rest of the number told how many times the next byte was repeated on the screen. If the high bit was 1, then the rest of the number told how many unique bytes followed in the table. Only one more slight change was required. Since the frequency byte had to be less than $80 (the high bit of a byte has a hex value of 80 and a decimal value of 128), the allowable range had to be from $00 to $7F. To simplify testing in the program, and to allow full use of the range, the frequency was changed to represent one less than the actual count.

Where does this leave us? A series of repeated bytes would still be represented as before, though the frequency byte would be one less than its actual value. So AA AA AA AA would be represented in the table as 03 AA. A series of unique bytes such as 07 FF 35 42 would be stored as 83 07 FF 35 42. This strategy resulted in only minor changes in the original program, followed by another program which produced the final table. Since this stripped-down table would be shorter than the original version, it could be stored in the same place without overwriting any information.

Basically, any entries in the original table representing repeated bytes would be left unchanged; any series of unique bytes would be shortened considerably by the removal of all those 01's. Picture Packer 3.0 functions fairly well. Pictures with a lot of background can be packed into as few as 11 sectors, while most pictures require around 24 sectors. I managed to cram 21 pictures on one disk under DOS 3.2.1, with lengths ranging from 11 to 29 sectors. Admittedly, some pictures don't pack too well, but in most cases the program does a good job of decreasing storage requirements.

The hidden bug (there's always a hidden bug) didn't appear until after a month of trouble-free use. Suddenly, certain pictures were turning into garbage when they were unpacked. Checking through the program, I discovered that it got confused when doing more than one pass on a picture that had unique bytes at both the start and end of screen memory. The repacking of the table just counted the number of unique bytes, it didn't notice that they belonged to different passes. The problem only appeared on certain Apples. The last eight bytes of screen memory are unused. Normally, this area will contain all 00's or all FF's, depending on the brand of RAM being used. In some Apples, this area will contain FF FF 00 00 FF FF 00 00. In such cases, the final table will be messed up. The fix was simple. At the start of the program, these last eight bytes are set to zero.

Using Picture Packer 3.0

The program contains only relative branches, so it can be placed anywhere in free memory. I usually load it into $1000. With the program in memory and a picture on hi-res page 1 ($2000), you simply give the command 1000G from the monitor (assuming the program is located at $1000), or use CALL 4096 from Basic. In about five seconds, the table is ready. The end of the table is stored in the first two bytes of memory ($00,$01). To save the table on disk you need to know the length. Just subtract $40 from the value in location $01, and use that for the hi byte of the length. (Since the table always starts at $4000, the hi byte of the length will be $40 less than the ending address shown in location $01.) To get the full length, append the lo byte value from location $00. For instance, if the first two locations in memory have the values $A2, $4C, the length of the table is $0CA2. (The length is actually $0CA3, but Apple DOS always stores one more byte than requested.) To put the above example on disk, use BSAVE TITLE, A$4000, L$CA2. From Basic, the command would be PRINT D$; "BSAVE TITLE, A$4000, L"; PEEK (0) + 256 * (PEEK(1) - 64).

Once pictures have been packed, the disk displaying them need only contain

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Picture Packer, continued...

the unpacking program. Again, it can reside almost anywhere in memory, as long as it doesn't conflict with program storage, screen memory, or table storage. The convenience of relocatability more than makes up for slight inefficiencies that sometimes occur in this type of code. Since the unpacker is only about $90 bytes long, it can be placed at the start of page 3 (768 decimal) without crashing any DOS hooks. To use it, just BLOAD the table and call the unpacking routine. The picture will be placed back into screen memory in several seconds. A sample program that displays a disk full of pictures is listed below.

```
10 D$="": REM  CONTROL D
20 PRINT D$;"BLOAD UNCRAM,A$1000"

30 GR : POKE -16297,0: POKE -16302
   ,0
40 FOR I=1 TO 21
50 PRINT D$;"BLOAD PICTURE";I
60 CALL 4096
70 NEXT I
80 END
```

A short program for displaying packed pictures.

How It Works

The program first sets bytes $3FF8-$3FFF to zero, then defines pointers for the start of screen memory and the start of the table. A flag is used to determine whether this is a test packing or the final run. Two other important variables are used. COUNT keeps track of the number of passes made during any individual packing. OFF is the offset used to get the sequence of screen bytes. This method allows the same program to be used for packing with one, two, or four passes. The main loop of the program starts by taking a byte from screen memory. Then the offset is added to the screen pointer and the next screen byte is compared with the previous byte. If they are the same, the Y register is incremented. When a different byte is found, it's time to make an entry in the table. The Y register is decremented, leaving it in a range of $00-$7F, then sent to the table, followed by the screen byte. This process is repeated until the end of the screen is reached.

Now the program has to check to see whether another pass is required for this particular packing attempt. COUNT is incremented and compared to OFF. If COUNT equals OFF, the table is done; if not, another pass is required for this packing. Once all passes have been made, the hi byte of the table length is stored. Next, OFF is doubled. This gives offsets of one, two, and four. Finally, after all versions have been tried, the table lengths are compared. The offset from the shortest table is used, and the flag is set so the program will stop after making this table. (A second might be saved here by changing the program so the four-pass pack, if the shortest, isn't repeated since the four-pass table is already in memory.) This completes the first portion of the packing. An $FF is tacked to the table, signaling the end.

Now we have a table that contains pairs of bytes. The first byte of each pair is one less than the number of times the second byte appears on the screen. Next, the table has to be stripped down. The REPACK section first takes a frequency byte from the table. If it is not $00 or $FF, then the next screen byte is not unique. In this case, the frequency byte and screen byte are just stored in the table. If the frequency is $00, the next byte is unique. In this case, the program branches to SINGLE. Here, unique bytes are stored until a frequency other than $00 is found. Y is used to count the number of unique bytes. When a frequency other than $00 is found, it's time to put the information in the table. Y is decremented by one, then EORed (Exclusive OR) with $80, setting the hi bit. After Y is placed in the table, the unique bytes are stored. This whole process is repeated until the table end (marked by $FF) is found. We now have a packed table representing screen memory.

Rather than look for more storage room, it seemed logical to try cramming the picture data into a smaller package.

Unpacker 3.0 reverses the process, turning the table into screen data. After the pointers are set up, a byte is taken from the table. If it is $80 or greater, then the next series of bytes are unique. In this case, the program branches to SING. Here, the hi bit is stripped and Y is incremented by one so it will represent the actual number of unique bytes following it in the table (remember, Y was decremented by one during the packing phase). The next Y bytes are sent to the screen. Again, the offset is used to increase the screen address, allowing the program to unpack tables made with any number of passes.

In the case of repeated bytes (marked by a frequency byte that is less than $80) the next byte is sent to the screen Y times (after Y is incremented by one). When the end of screen memory is reached, a check is made to see if another pass is required. If not, the unpacking is finished.

Final Notes

As I said, the program is not perfect. I've encountered several pictures that couldn't be reduced. The packing provided no saving of space. But, in most cases, picture storage can be significantly reduced. Those of you who like to experiment might want to rewrite the program so it steps through screen memory not in ascending order, but in the same order used by the memory mapping. You could also try stepping past the unused bytes in screen memory which occur at $XX78-$XX7F and $XXF8-$XXFF.

The program puts the picture on the screen rather quickly, with visual effects that vary depending on the number of passes used. Beyond being used to store a series of pictures, the program could be handy if you have a large program or set of programs on a disk and want to add a title picture. It's no longer necessary to set aside 33 sectors for this. Also, Unpacker 3.0 is handy when you are making changes to a picture. By keeping the table in memory, a damaged picture can be quickly restored by unpacking it back to the screen.

The same approach could probably be used on the Atari. The packing would probably be even greater since Atari doesn't use the same strange odd-even hi bit technique that adds complications to Apple pictures. Any memory mapped screen could be packed this way, including the lo-res PET or TRS-80 screen (of course, a TRS-80 version would have to be rewritten in Z80 code).

I'll probably get hooked again some time and try to knock a few more sectors off the pictures. Perhaps this program can be improved. Perhaps another approach is needed. Whatever, I hope Picture Packer 3.0 and Unpacker 3.0 prove useful. □

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Picture Packer, continued...

```
:ASM
                  *PICTURE PACKER 3.0
                           ORG  $1000
                  SCLO     EQU  0        :POINTERS TO SCREEN MEMORY
                  SCHI     EQU  1
                  TABLO    EQU  2        :POINTERS TO TABLE
                  TABHI    EQU  3
                  OFF      EQU  4        :OFFSET FOR STEPPING
                                                   THROUGH SCREEN
                  COUNT    EQU  5        :COUNTER FOR PASSES
                  FLAG     EQU  6        :INDICATES TEST PASS OR
                                                   FINAL PASS
                  FLAG1    EQU  7
1000: A9 00       FIX      LDA  #$0      :TAKES CARE OF A SMALL
1002: A2 08                LDX  #$08     :BUT DEADLY BUG BY
1004: 9D F8 3F    FIX1     STA  $3FF8,X  :ZEROING THE LAST
1007: CA                   DEX           :EIGHT BYTES OF SCREEN MEMORY
1008: 10 FA                BPL  FIX1
100A: A9 00       SET      LDA  #$0
100C: 85 06                STA  FLAG     :INDICATE TEST PASS
100E: A9 01                LDA  #$1      :START WITH SINGLE PASS
1010: 85 04                STA  OFF      :WITH OFFSET OF ONE
1012: A9 01       SET1     LDA  #$1      :SET TABLE POINTERS
1014: 85 02                STA  TABLO
1016: A9 40                LDA  #$40
1018: 85 03                STA  TABHI
101A: A9 00                LDA  #0       :SET UP COUNTER TO KEEP
101C: 85 05                STA  COUNT    :TRACK OF PASSES
101E: A9 20       SET2     LDA  #$20     :SET SCREEN POINTERS
1020: 85 01                STA  SCHI
1022: A5 05                LDA  COUNT    :VALUE IN COUNTER GIVES
1024: 85 00                STA  SCLO     :LO BYTE OF SCREEN START
1026: A9 00                LDA  #$0      :ZERO X AND Y
1028: AA                   TAX
1029: A8                   TAY
102A: A1 00       START    LDA  (SCLO,X) :GET A BYTE FROM THE
102C: 48          LOOP     PHA           :SCREEN AND SAVE IT
102D: A5 00                LDA  SCLO     :GET NEXT ADDRESS BY
102F: 18                   CLC           :ADDING OFFSET TO SCREEN
1030: 65 04                ADC  OFF      :POINTER
1032: 85 00                STA  SCLO
1034: 90 08                BCC  CONT
1036: E6 01                INC  SCHI
1038: A5 01                LDA  SCHI     :CHECK FOR END OF SCREEN
103A: C9 40                CMP  #$40
103C: F0 20                BEQ  DONE
103E: 68          CONT     PLA           :RECOVER SCREEN BYTE
103F: C8                   INY           :COUNT THE FREQUENCY OR REPEATS
1040: 30 04                BMI  PAGE     :MAXIMUM IS $80
1042: C1 00                CMP  (SCLO,X) :LOOK FOR A DUPLICATE
                                                   SCREEN BYTE
1044: F0 E6                BEQ  LOOP     :FOUND ONE
1046: 48          PAGE     PHA           :SAVE SCREEN BYTE
1047: 88                   DEY           :ADJUST TO $00-$7F RANGE
1048: 98                   TYA
1049: 81 02                STA  (TABLO,X) :PUT FREQUENCY IN TABLE
104B: E6 02                INC  TABLO    :INCREASE TABLE POINTER
104D: D0 02                BNE  CONT1
104F: E6 03                INC  TABHI
1051: 68          CONT1    PLA           :RECOVER SCREEN BYTE
1052: 81 02                STA  (TABLO,X) :SEND IT TO THE TABLE
1054: E6 02                INC  TABLO    :INCREASE POINTER AGAIN
1056: D0 02                BNE  CONT2
1058: E6 03                INC  TABHI
105A: A0 00       CONT2    LDY  #$0      :PUT FREQUENCY BACK TO 0
105C: F0 CC                BEQ  START    :ALWAYS TAKEN
105E: 98          DONE     TYA           :SEND FINAL FREQUENCY OF
105F: 81 02                STA  (TABLO,X) :PASS TO THE TABLE
1061: E6 02                INC  TABLO
1063: D0 02                BNE  CONT5
1065: E6 03                INC  TABHI
1067: 68          CONT5    PLA           :RECOVER FINAL SCREEN BYTE
1068: 81 02                STA  (TABLO,X) :AND SEND TO TABLE
106A: E6 02                INC  TABLO
106C: D0 02                BNE  CONT6
106E: E6 03                INC  TABHI
1070: E6 05       CONT6    INC  COUNT    :INCREASE COUNTER
1072: A5 05                LDA  COUNT    :IF COUNT=OFF, THEN ALL
1074: C5 04                CMP  OFF      :PASSES ARE DONE FOR THIS TRY
1076: D0 A6                BNE  SET2     :IF NOT DONE, GO BACK
1078: A5 06                LDA  FLAG     :TEST PASS?
107A: D0 2C                BNE  OUT      :NO, GET OUT
107C: A5 03       NEXT     LDA  TABHI    :YES, STORE HI BYTE OF
107E: A6 04                LDX  OFF      :TABLE LENGTH FOR COMPARISON
1080: 95 06                STA  FLAG,X   :AFTER ALL TRIES ARE DONE
1082: A5 04                LDA  OFF
```

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Picture Packing, continued...

```
1084: AA                      ASL          ;DOUBLE OFFSET
1085: 85 04                   STA   OFF
1087: C9 08                   CMP   #$8    ;HAVE 1, 2, AND 4
                                                  PASSES BEEN TRIED?
1089: D0 87          WAY      BNE   SET1   ;NO, GO BACK
108B: A0 01          TEST     LDY   #$1    ;YES, CHECK STORED TABLE
108D: A5 07                   LDA   $7     ;LENGTHS TO FIND SHORTEST
108F: C5 08                   CMP   $8     ;METHOD OF PACKING
1091: 90 04                   BCC   TEST1
1093: A0 02                   LDY   #$2
1095: A5 08                   LDA   $8
1097: C5 0A          TEST1    CMP   $A
1099: 90 02                   BCC   TEST2
109B: A0 04                   LDY   #$4
109D: 84 04          TEST2    STY   OFF    ;SAVE OFFSET OF BEST
109F: 8C 00 40                STY   $4000  ;METHOD AND PUT INTO TABLE
10A2: A9 01                   LDA   #1     ;SET FLAG TO INDICATE
10A4: 85 06                   STA   FLAG   ;THIS IS NOT A TEST PASS
10A6: D0 E1                   BNE   WAY    ;GO BACK FOR FINAL PACK
10A8: A9 FF          OUT      LDA   #$FF   ;MARK END OF TABLE
10AA: 81 02                   STA   (TABLO,X)
                     *SECOND PHASE BEGINS HERE
10AC: A9 01          REPACK   LDA   #1     ;SET POINTERS USING
10AE: 85 02                   STA   TABLO  ;TABLO AND TABHI FOR ORIGINAL
10B0: 85 00                   STA   SCLO   ;TABLE. SCLO AND SCHI ARE
10B2: A9 40                   LDA   #$40   ;USED FOR NEW TABLE
10B4: 85 03                   STA   TABHI
10B6: 85 01                   STA   SCHI
10B8: A2 00                   LDX   #0
10BA: A1 02          LOOP3    LDA   (TABLO,X) ;GET FREQUENCY
10BC: F0 23                   BEQ   SINGLE ;0 SIGNIFIES UNIQUE BYTE FOLLOWS
10BE: 30 20                   BMI   DONE2  ;END OF OLD TABLE MARKED BY $FF
10C0: 81 00                   STA   (SCLO,X) ;FOR FREQUENCIES FROM 1
10C2: E6 02                   INC   TABLO  ;TO $FF, FREQUENCY AND
10C4: D0 02                   BNE   CNT1   ;SCREEN BYTE ARE SENT
10C6: E6 03                   INC   TABHI  ;RIGHT TO THE TABLE
10C8: E6 00          CNT1     INC   SCLO
10CA: D0 02                   BNE   CNT2
10CC: E6 01                   INC   SCHI
10CE: A1 02          CNT2     LDA   (TABLO,X)
10D0: 81 00                   STA   (SCLO,X)
10D2: E6 02                   INC   TABLO
10D4: D0 02                   BNE   CNT3
10D6: E6 03                   INC   TABHI
10D8: E6 00          CNT3     INC   SCLO
10DA: D0 DE                   BNE   LOOP3
10DC: E6 01                   INC   SCHI
10DE: D0 DA                   BNE   LOOP3  ;ALWAYS TAKEN
10E0: 60             DONE2    RTS          ;EXIT POINT FROM ROUTINE
10E1: A8             SINGLE   TAY          ;UNIQUE BYTES ARE HANDLED HERE
10E2: 85 06                   STA   FLAG   ;SET POINTERS FOR TEMPORARY
10E4: A9 03                   LDA   #3     ;STORAGE IN PAGE 3
10E6: 85 07                   STA   FLAG1
10E8: E6 02          LOOP4    INC   TABLO
10EA: D0 02                   BNE   CNT4
10EC: E6 03                   INC   TABHI
10EE: A1 02          CNT4     LDA   (TABLO,X) ;GET SCREEN BYTE FROM
10F0: 91 06                   STA   (FLAG),Y ;TABLE AND STORE IN PAGE 3
10F2: E6 02                   INC   TABLO
10F4: D0 02                   BNE   CNT5
10F6: E6 03                   INC   TABHI
10F8: C8             CNT5     INY          ;INCREASE COUNT OF UNIQUE BYTES
10F9: 30 04                   BMI   PAGE2  ;VALUE CAN'T BE ABOVE $80
10FB: A1 02                   LDA   (TABLO,X) ;GET NEXT FREQUENCY BYTE
10FD: F0 E9                   BEQ   LOOP4  IF ANOTHER SINGLE, THEN GO BACK
10FF: 88             PAGE2    DEY          ;ADJUST FOR $00-$7F RANGE
1100: 98                      TYA
1101: 09 80                   ORA   #$80   ;SET HI BIT
1103: 81 00                   STA   (SCLO,X) ;SEND IT TO NEW TABLE
1105: E6 00                   INC   SCLO
1107: D0 02                   BNE   CNT6
1109: E6 01                   INC   SCHI
110B: C8             CNT6     INY          ;RESTORE TO ORIGINAL VALUE
110C: A1 06          LOOP5    LDA   (FLAG,X) ;AND USE AS COUNTER
110E: 81 00                   STA   (SCLO,X) ;WHILE SENDING UNIQUE
1110: E6 06                   INC   FLAG   ;BYTES TO THE TABLE
1112: E6 00                   INC   SCLO
1114: D0 02                   BNE   CNT7
1116: E6 01                   INC   SCHI
1118: 88             CNT7     DEY          ;DONE WITH DATE IN PAGE 3?
1119: D0 F1                   BNE   LOOP5  ;NO, KEEP GOING
111B: F0 9D                   BEQ   LOOP3  ;YES, GET NEXT FREQUENCY

--- END ASSEMBLY ---

TOTAL ERRORS: 0

285 BYTES GENERATED THIS ASSEMBLY
```

Unpacker Listing

```
:ASM
                UNPACKER 3.0
                          ORG   $900
                SCLO      EQU   0
                SCHI      EQU   1
                TABLO     EQU   2
                TABHI     EQU   3
                OFF       EQU   4
                COUNT     EQU   5
0900: AD 00 40  SETUP     LDA   $4000    ;GET NUMBER OF PASSES
0903: 85 04               STA   OFF      ;FROM TABLE AND USE FOR OFFSET
0905: A9 01               LDA   #1       ;SET UP POINTERS TO TABLE
0907: 85 02               STA   TABLO
0909: A9 40               LDA   #$40
090B: 85 03               STA   TABHI
090D: A9 00               LDA   #0
090F: AA                  TAX
0910: 85 05               STA   COUNT    ;START COUNT AT 0
0912: A9 20     SET2      LDA   #$20     ;SET SCREEN POINTERS
0914: 85 01               STA   SCHI
0916: A5 05               LDA   COUNT    ;USE COUNT FOR LO BYTE
0918: 85 00               STA   SCLO     ;OF SCREEN START
091A: A1 02     START1    LDA   (TABLO,X) ;GET FREQUENCY BYTE
091C: 30 3A               BMI   SING     ;IF HI BIT IS SET,
                                          UNIQUE BYTES FOLLOW
091E: E6 02               INC   TABLO    ;MOVE THROUGH TABLE TO GET
0920: D0 02               BNE   CON1     ;SCREEN BYTE
0922: E6 03               INC   TABHI
0924: A8        CON1      TAY            ;PUT FREQUENCY IN Y
0925: C8                  INY            ;AND RESTORE TO ACTUAL VALUE
0926: A1 02               LDA   (TABLO,X) ;GET SCREEN BYTE
0928: 81 00     LOOP1     STA   (SCLO,X) ;SEND IT TO THE SCREEN
092A: 48                  PHA            ;SAVE IT
092B: A5 00               LDA   SCLO     ;ADD OFFSET TO SCREEN POINTER
092D: 18                  CLC
092E: 65 04               ADC   OFF
0930: 85 00               STA   SCLO
0932: 90 08               BCC   CON3
0934: E6 01               INC   SCHI
0936: A5 01               LDA   SCHI
0938: C9 40               CMP   #$40     ;END OF SCREEN?
093A: F0 0C               BEQ   OUT1     ;YES
093C: 68        CON3      PLA            ;NO, GET SCREEN BYTE BACK
093D: 88                  DEY            ;DECREASE FREQUENCY
093E: D0 E8               BNE   LOOP1    NOT DONE, KEEP SENDING
                                                   SAME BYTE TO SC
0940: E6 02               INC   TABLO    ;GET READY FOR NEXT ENTRY
0942: D0 D6               BNE   START1   ;AND GO BACK
0944: E6 03               INC   TABHI
0946: D0 D2               BNE   START1   ;ALWAYS TAKEN
0948: 68        OUT1      PLA            ;RESTORE STACK
0949: E6 02     OUT2      INC   TABLO
094B: D0 02               BNE   CON9
094D: E6 03               INC   TABHI
094F: E6 05     CON9      INC   COUNT    ;INCREASE COUNT AND
0951: A5 05               LDA   COUNT    ;CHECK WHETHER ANOTHER
0953: C5 04               CMP   OFF      ;PASS IS NEEDED
0955: D0 BB               BNE   SET2     ;YES, GO BACK
0957: 60                  RTS            ;NO, ALL DONE
0958: 49 80     SING      EOR   #$80     ;REMOVE HI BIT
095A: A8                  TAY   PUT      FREQUENCY OF UNIQUE BYTES IN Y
095B: C8                  INY   AND      RESTORE TO ACTUAL VALUE
095C: E6 02               INC   TABLO    ;GET NEXT SCREEN BYTE FROM TABLE
095E: D0 02               BNE   LOOP5
0960: E6 03               INC   TABHI
0962: A1 02     LOOP5     LDA   (TABLO,X)
0964: 81 00               STA   (SCLO,X) ;SEND IT TO THE SCREEN
0966: E6 02               INC   TABLO
0968: D0 02               BNE   CON6
096A: E6 03               INC   TABHI
096C: A5 00     CON6      LDA   SCLO     ;POINT TO NEXT SCREEN LOCATION
096E: 18                  CLC
096F: 65 04               ADC   OFF
0971: 85 00               STA   SCLO
0973: 90 08               BCC   CON7
0975: E6 01               INC   SCHI
0977: A5 01               LDA   SCHI
0979: C9 40               CMP   #$40     ;END OF SCREEN?
097B: F0 D2               BEQ   CON9     ;YES
097D: 88        CON7      DEY            ;NO, DECREASE FREQUENCY
097E: D0 E2               BNE   LOOP5    ;GO BACK FOR MORE UNIQUE BYTES
0980: F0 98               BEQ   START1   ;DONE WITH THIS SERIES

--- END ASSEMBLY ---

TOTAL ERRORS: 0

130 BYTES GENERATED THIS ASSEMBLY
```

Higher Graphics — Easier Shapes

Dale Archibald

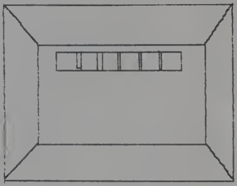

Figure 2.

Figure 3.

I am a fledgling programmer, trying to learn as I thumb through books, and through periodicals such as *Creative Computing*.

My main purpose in getting an Apple in the first place was to simplify writing newspaper and magazine articles. Second, of course, to playing games. Graphics? No way. I wasn't interested.

Then I bought an MPI 88G printer. It was equipped with a program to print graphics, but I still wasn't willing to go out and buy anything for graphics; I simply didn't know or care enough.

Then Robert C. Clardy shipped me some game programs from Synergistic Software (5221 120th Ave. S.E., Bellevue, WA 98006) for review. He must have included Higher Graphics II by accident. Since it would operate on either a 48K Apple II or Apple II Plus with a single disk drive, I decided to test it.

Figure 1.

I tried drawing a character and some objects in hi-res graphics as in Figure 1. Then I drew a few more. Next I worked on a room for the characters and objects, shown in Figure 2. To make a long story short, thanks to Higher Graphics II, I've become fascinated with the extra dimension that can be added by these tiny little dots.

Description

There are three basic sections to Higher Graphics II. First is a section on composing individual shapes, then one on

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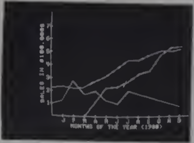
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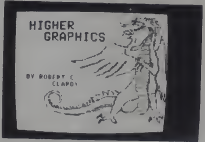

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shuffling the shapes around, and finally a screen creator to make backgrounds for the shapes. Nearly every command is given by touching one key.

When you're ready to draw a shape with the Shape Maker, you're put into the Command Mode. This allows you to load an existing shape table as a reference if you wish. As you work, you may choose to View the shapes in the current table, Delete a shape, Save the current table to disk; or give other minor commands. All are given from the Command Mode.

A second mode in the Shape Maker is Add Shape. This allows you to draw the shape dot-by-dot in a variety of colors, angles, and scales. (These, by the way, are only shown during the creation of the shape. It's necessary to specify them in the program when using the shape.) The command Plot turns the dot on or off. Coordinates of the dot are shown, as are the number of bytes used, memory location, and shape number.

If you should make a mistake, hitting E erases the last two or three ponts. Control E wipes the shape completely off the screen and out of memory. Using Z allows you to bring any shape out of memory to use as a reference.

Once you have several shapes saved, in addition to the 60 that are included with Higher Graphics II, you may want to compile new tables. The Shape Shuffler allows you to do this. Let's assume you have a boy and an English sheepdog in one table, a mongrel in another. You want to put the boy and the mutt together.

Shape Shuffler first asks how many shapes will be in the new table. Let's assume there will be two. Load the mutt into the Shuffler Table 2, the boy and the purebred into Table 1. Display shape 1, the boy, from Table 1. Hit T to Transfer the boy to Table 2, then Save Table 2 under the file name you want: BOY AND HIS MUTT, for example. Both Tables 1 and 2 are left in memory for further adjustments.

If you're a purist, you might want to Insert the sheepdog in place of the mutt into a table. This is handy when you have a large number of shapes to deal with. Depending upon your programming needs, you can collect shape after shape from various shape tables to form a completely new one. You can Display any shape in either table at any time, or change angle, scale, or color. You can even display all shapes in either table, 50 at a time.

Now you have the BOY AND HIS MUTT. Where are they going to gambol? That's where the Screen Creator portion of the program comes into play. The Screens, referred to as hi-res Screen 1 (Main) and Screen 2 (Secondary) in Higher Graphics II, are actually pages 1 and 2 of the hi-res graphics.

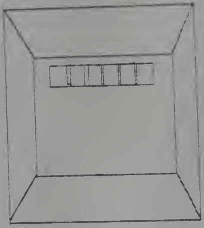

Figure 4.

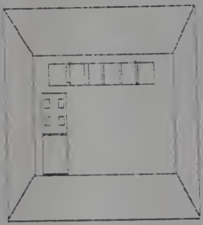

Figure 5.

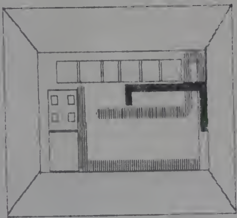

Figure 6.

This lets you form shapes and manipulate shape tables to make hi-res displays such as charts, game boards, rooms, fields, etc. It is even possible to print these out, as discussed later.

Figure 3 illustrates how the Screen Creator works. The numbers and letters are shapes from the ASCII set that comes as a table with Higher Graphics II. The witch, lightning bolts, and ball of fire(?) are my designs, as is the chart on which they are stationed.

In the command mode, you can Type letters in the angle, scale, and color you select. You specify where to begin on the screen using the game paddles. You can erase by backspacing.

You can also: use Lines or Points; load various shape tables; show the Secondary hi-res screen as a reference or to sample the various shapes in the shape table; load a saved screen in either the Main or Secondary screen to use as a reference or to add some more touches to it; save a screen to work on later; erase the working screen; or move the screen up, down, left, or right, full-screen or with four lines of text at the bottom.

If you select Draw Shape while in the Command Mode, you can pick shapes from various tables. You can then manipulate them into place, whether up, down, right, or left; use the game paddles to move them; put them at a certain X,Y coordinate; show them in color; change scale or angle; Erase a working shape; Type letters; and more.

Using the Program

In Figure 4, I used the paddles to draw the picture of the room. Note the bars in the window are different sizes, and there is no door or "color" on the walls.

I used two squares to put the door in Figure 5 in place. The door frame is based on one large square. I selected it from the shape table, and fixed it into place on the screen with the aid of the game paddles. I returned to the table, took the same shape, and maneuvered it into place as the top half. Next, I took a small square from the shape table and used the paddles to put it in the upper top left of my new door. I went back, took the shape again and put it in the upper right of the door. I did this twice more. Thus, I "assembled" the door from shapes in the shape table.

Then I decided to see if I could "paint" the room. Higher Graphics II informed me that pressing V, G, B, O, W, or K would turn the working shape (i.e., the shape being manipulated) violet, green, blue, orange, white, or black. The shape acts as a paint brush, leaving an area of color behind it.

The area that begins in left center of Figure 6 and goes straight right was orange; the thick line that goes up, in the middle of the room, was black; the right far corner of the room at the bottom, next to the floor, was black, but I "erased" that with white.

You'll notice I also touched up the two left bars in the window and the bar on the far right. The crookedness of the lines, by the way, is due to the printer: I used it on sprocket feed, rather than pinch feed.

So you can erase errors on the screens just by touching them up with dots of the correct color. Once you've saved them onto disk, the basic screens can be used again and again, filled with any shapes you desire.

All commands that would erase a drawing, table, or screen give you an opportunity to abort. Even FILE NOT FOUND errors, or I/O ERRORs, can be retrieved intact. Hit RESET? No problem. Programs can be reentered with everything intact just by typing GOTO 10000. It's practically a foolproof program, but of course that never stops me.

I've had two drawings in the Shape Maker just disappear in the middle of working on them. One had over 300 bytes devoted to it; perhaps the other did, also.

The crosshairs that show where the point will appear in the Add Shape mode are too large, and too far apart, you can erase or use them, as desired.

Drawing straight lines with the Screen Creator using the game paddles is difficult; the paddles are just too sensitive, and one dot awry on a thin straight line looks terrible. It would probably be possible to correct these in the Draw Shape mode, however.

Documentation

I have mixed feelings about the instruction manual. In some ways it is very good. It describes almost everything you'd need to know about the program, but I feel it assumes too much knowledge on the part of the user. Six of the 24 pages are given over to discussing hi-res, but only in Integer.

To print a hard copy of any shape in any shape table, simply run the Screen Creator and put the chosen table in memory. Place your choices on the screen in Draw Shape mode, from as many tables as you wish, and Save. Later, you can reload the picture and print it out, assuming your printer has graphics capabilities. If your graphics printer program is like mine, you'll get a handy hard copy. Maps, graphs, charts, whatever, which can be updated in a trice.

Summary

With my limited experience, I'd have to say Higher Graphics II is great. Adding graphics to something you've written yourself gives it much more excitement and life. I highly recommend trying it. Higher Graphics II is a good way to begin.

I couldn't get the program listed in the manual to work for me. All it does is make a little tank, SHAPE=37, move from left to right across the screen. I came up with the simple animation in Listing 1.

```
5  LOMEM: 16384
10  SCALE= 1:SHAPE = 37: ROT= 0:
     POKE
     232,0: POKE 233,12:D$ =  CHR$
     (4): REM                  CONTR
     OL D
20  PRINT D$;"BLOAD HIRES"
30  PRINT D$;"BLOAD SHAPES, A3072
              "
40  HGR
50 XO = 10:YO = 100: XDRAW SHAPE AT
     XO,YO
60  FOR I = 1 TO 10: NEXT I
70 A =  PEEK ( - 16336): XDRAW SH
     APE AT XO,YO:A =  PEEK ( - 1
     6336):XO = (XO + 1):A =  PEEK
     ( - 16336): XDRAW SHAPE AT X
     O,YO: IF XO < 279 THEN 60
```

Listing 1.

The LOMEM sets the variable table above any possible graphics design.

Line 10 sets up the requirements for the tank, except color. The color will be white (complementary of black) when using XDRAW or a black background.

Line 20 isn't necessary in Applesoft.

Line 30 loads the binary shapes beginning at 3072.

Line 50 XDRAWs the tank at the given X,Y coordinates.

Line 60 slows it down enough to see.

Line 70 makes the noise and XDRAWs the tank out, changes position, XDRAWs it in, XDRAWs it out, and goes back to line 60 until it reaches the end.

Clardy suggests adding paddle commands, and making a game out of it. Not a bad idea. □

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PAY 5 - reports all outstanding Accounts Payables for a single date or for a range of dates and computes the Cash Requirements.
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REC 4 - reports all outstanding Accounts Receivables for a single customer, or for all customers and computes Cash Projections.
REC 5 - produces reports for all outstanding Accounts Receivables for a single date or for a range of dates and computes Cash projections.
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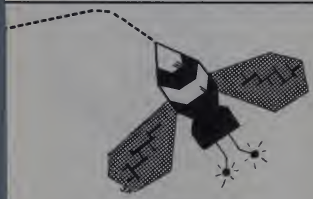


BEE AMAZED

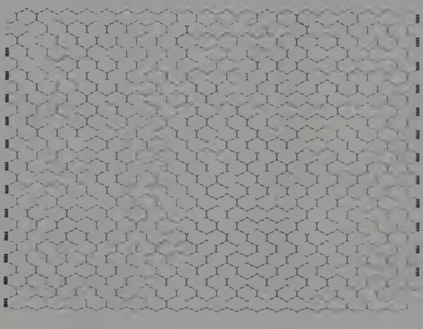
Dan Rollins

There is a certain fascination in the way a computer can create and solve a maze. This article explains the algorithms I used in Beemaze, a program which generates and finds the shortest path through a maze of hexagonal cells.

The program is written in TRS-80 Level 2 Basic, and parts of it use the TRS-80 graphics. However, all the routines used in creating the printout are compatible with similar Basics.

For TRS-80 users, the program provides a special treat. The maze is created graphically on the screen. When the maze is completed, you'll watch as the bee searches for the shortest route. Then man is pitted against insect in a race through the maze. If you choose the print output option, a much larger maze may be created. A 16K machine will handle a maze with 2700 elements. My 48K disk system turned out a maze with 6500 elements—a printout over ten feet long!

There are two options for the printer output. You may make copies of the maze with or without the solution. Distribute the unsolved versions among your friends, and when they claim that the monster is unsolvable, give them a brief peek at the answer.



Example 1a. Printout without solution.

Generating the Maze

The maze is represented in computer memory as a two-dimensional integer array. Each array element (or cell) is defined by a numerical value of 0 to 63 in the following manner. Every SIDE of a cell has been assigned a number (see Figure 1a). The overall value of a cell is determined by the sum of the values for all sides of the cell which have a door. For example, a cell with no doors is a zero cell. A cell with doors valued 1 and 16 will be given a value of 17. If a cell has three doors, e.g. 1, 4, and 16, it is valued at 21. These numbers correspond to bit posi-

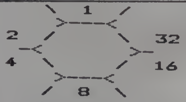


Figure 1a. Values representing the doors of each cell. Cells with two or more doors will be the sum of the respective doors.

Dan Rollins, 370 N. Cerritos, Apt. 15-A, Azusa, CA 91702.

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tions in a byte of memory. (More on that in a minute.) The variables X and Y are pointers to a vertical column and horizontal row respectively. Initialized randomly, these pointers are manipulated within the array, moving from cell to cell.

Note a peculiar property of this hexagonal array representation. In a normal array of "square" cells, pointers are manipulated north or south by simply adjusting the Y variable. East and west motion is performed by bumping the X pointer. But each cell of this array neighbors *six* other cells and motion is possible in as many directions (N,S,NE, NW,SE,SW). Examine Figure 2. Motion

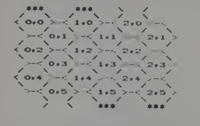


Figure 2. How the cells are numbered in the two-dimensional integer array.

north is accomplished by subtracting 2 from Y. Likewise, 2 is added to Y for motion south. However, to adjust the pointers in a diagonal motion (NE,NW, SE,SW), special attention must be paid to the current Y coordinate. For example, when Y is an even number (evenly divisible by 2), then moving SE requires that Y be incremented and X be left alone. If Y is an odd number, the same motion requires that both X and Y be incremented.

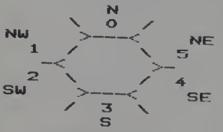


Figure 1b. Possible directions for the bee to turn in the maze solution algorithm.

The variable Z is used to account for this variation. Several lines in the program evaluate Z as -((Y AND 1)=1). TRS-80 Basic will return Z=0 when Y is even and Z=1 when Y is odd. Your Basic may require something like:

```
IFY/2=INT(Y/2)THENZ=0ELSEZ=1
```

The direction of motion is determined in lines 120-200. Six neighboring cells are checked for a zero (doorless) condition. A short list, held in T(Q), is compiled from the possible directions of travel (see Figure 1b). One of these directions is chosen randomly, and the ON..GOTO command sends control to the line for the correct action. Here, the current cell is updated with a value indicating a door in that direction and the X,Y variables are adjusted to point to the new cell. That cell is then given the value for its new door and, if the game option was chosen, the screen is updated.

A single walk-through will determine the best route.

When the program finds itself trapped, e.g. when none of the neighboring cells is still zero, the pointers are moved down and across the array until a doorless cell is located which is adjacent to a cell with at least one door. Thus all branches are linked—there are no "islands" of unconnected cells in the completed maze. Any individual cell may be reached from any other. Indeed, though I chose to place them at opposite corners, the entrace and exit may be randomly created after the entire maze is completed. Another advantage is that the solution, the direct path from entrance to exit, will be unique.

Solving the Maze

When the IEEE (Institute of Electrical and Electronic Engineers) holds its Micromouse Maze contest, tiny mechanical robots compete in finding their way through a maze. They are given three tries to obtain the best possible time. The maze they run may have many solutions, only one of which is the fastest. One method of finding this path is called the "leftmost/ rightmost" algorithm. On the first traversal, whenever an opening to the left is sensed, the "mouse" rotates and follows that path. On the second run, doors to the right are taken. Coordinates of each position are saved in on-board memory. After the two runs, the paths are compared for common intersections. Superfluous loops are eliminated and the shortest path is computed from the stored data. Some other factors are considered such as rotating speed—a longer, straighter path may be quicker than a path shorter in distance but having many turns. Finally, the optimized third run is made.

The "bee" in this program uses a similar system. The algorithm is simplifed by the fact that a single walk-through will determine the best route. It must be extended, however, to allow for the six possible exits from each cell. In this "clockwise" algorithm, the correct cell exit will be the first door clockwise of the door used as the entrance.

Consider the course of action as the bee traverses the maze. It enters a cell, records the coordinates, and begins rotating in clockwise direction. The first opening it sees determines the direction of travel and it moves in that direction into the adjacent cell. The bee moves from cell to cell until it reaches a cul-de-sac (dead end). In that case, rotation brings it back to the door thouh which it entered. The next cell it enters is the one it just vacated. Now the bee is facing in a direction *different* from it previous visit. Rotation brings it to another exit, possibly the one by which it originally entered the cell, but never back into the cul-de-sac. The bee searches through its memory and notes that it has been there before. It then deletes the cul-de-sac from its best-path list and continues until the exit is reached.

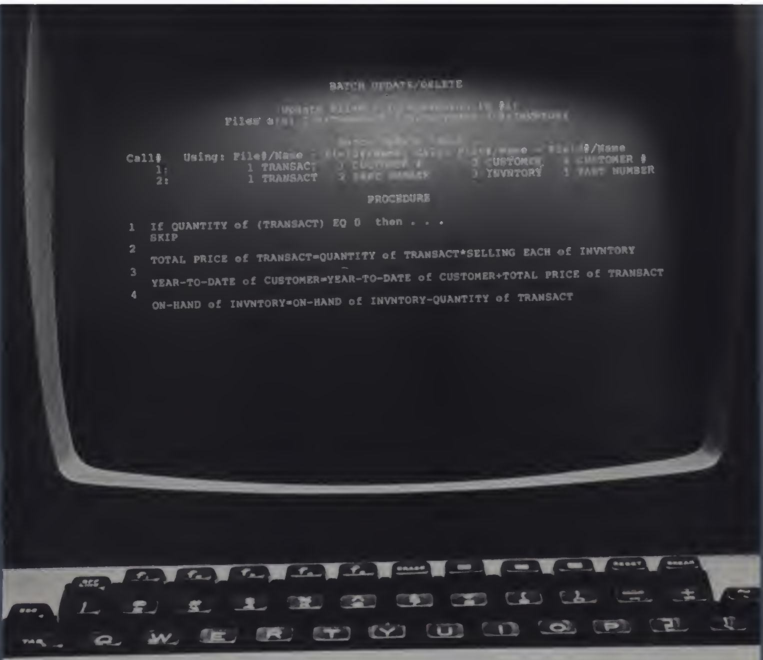
Think of the X,Y pointers in the program as the bee. Its current direction is kept in the variable D. As the bee enters a cell, the last door it should check is the one directly behind it. If it entered by going south then that door is now to its north. The program reinitializes the direction by subtracting 3 from D, then adjusting for underflow (adding 6 if the result is less than zero). The actual rotation is performed by repeatedly decrementing D (again adjusting for underflow). At every turn, the cell is tested for a door in the current direction.

Refering back to Figures 1a and 1b, notice the relationship between the values of a direction and a door in that direction. Each door corresponds to the power of 2 defined by the direction. This system is set up to use the powerful bit-manipulation of the AND command. When two numbers are ANDed they are compared on a bit by bit basis. The result, shown in Figure 3, is a value composed of only the ON bits common to both.

	decimal	binary	doors
	19 =	00010011 =	x x x SE x x NW N
AND	16 =	00010000 =	x x x SE x x x x
result	16=	00010000	SE

Figure 3.

ANDing two numbers which have no ON bits in common will return a zero as the result. The program lines asking ....IF var1 AND var2 THEN...are checking for common bits. The IF fails and excution falls through when the logical AND results in a non-zero value.



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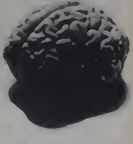

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When the maze was created, certain bits of each cell were turned ON, defining the doors. Now, by testing the state of a given bit, the maze runner can sense the presence of a door. The program computes 2 ↑ D, then ANDs this value with the value of the cell. A non-zero result indicates that there is indeed a door so the bee, taking that direction, enters the new cell.

The real value of this sytem is not only the ease with which the maze data is handled, but in the compactness of that data. A single integer defines both the number of doors and their locations. Also, a cell may take on additional aspects just by turning on new bits. After the best route has been determined, the cells along that path are increased by 64. The printer routine senses this for marking the solution. By adding 128, a new factor could be introduced to certain cells. Perhaps a queen bee or some honey might be found there.

The maze runner algorithm always yields a list of the coordinates which make up the shortest route from the start of the maze to the end. But as described, it's too slow. For example, a cul-de-sac would require six complete turns to locate the exit. There are a couple of shortcuts I used to speed the bee along.

First, that cul-de-sac may be deduced by the fact that the value of the cell is exactly equal to that of the door by which it entered. No sense in rotating here, so the bee simply reverses direction and exits.

Secondly, a test is made for a two-doored cell. The door is subtracted from the cell. If the difference is exactly a power of 2 then there is only one other exit and it is determined as in line 670.

Only when there are more than two doors (the least likely occurrence) is the clockwise algorithm invoked.

The bee's advantage is offset by the fact that it must perform a little dance in each cell.

All three possibilities return a new direction in the variable D. This value is used in the ON...GOTO sequence to adjust the X,Y array pointers to the next cell. Execution resumes by saving the new position and repeating the action of finding the maze exit.

The multiple-door cells also triggers the routine which updates the best-route list. It is here that the selective "forgetting" of deadend paths is performed. A FOR... NEXT loop checks backwards through the best-route list comparing each saved coordinate against the current one. If a match is found then the best-path list counter, PTR, is set to the loop counter and the loop is exited. Coordinates of the next cells visited will be written over the superfluous steps, in effect erasing them from memory.

The Printout

The printer output routine is designed for printer portability. Lines 830-900 define the character strings which correspond to the walls and doors of the maze. I used FS$ and BS$ in lines 880-890 because my TRS-80 has no key for the backslash character. If your printer has graphics capabilities, it will be easy to experiment with different combinations, as they need be typed at only one place.

Lines 940-950 print the top output line. Lines 960-1060 examine the body of the array, printing four lines for two vertical coordinates. The last three lines (the bottom cell) are printed in lines 1070-1130.

The examples I've included were printed on an IDS 440 Paper Tiger set at 132 characters per line and 8 lines per inch. These settings allow a horizontal dimension of 16 with a height of 40 to be fit on a single page.

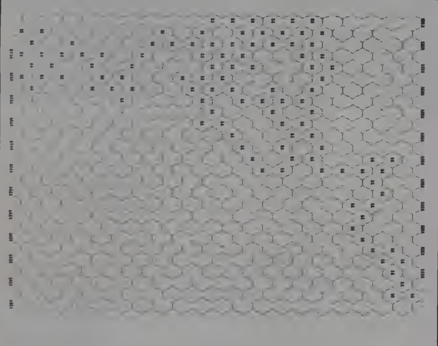
The best-route is represented by cells containing "**." These characters will never be printed until the routine at lines 770-810 has been called. Once this is done, all further printouts will have the solution.

The Race

Game players of all ages will enjoy the challenge of racing the bee through the maze. Once the maze is generated, the screen is saved in a string array. Note that four bytes of the 1024 in the TRS-80 screen memory are ignored as a string can only be 255 bytes long. When the screen is redrawn (line 2480) one space is inserted between each string to account for this.

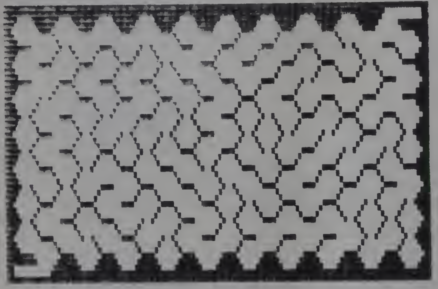
After a short countdown, the screen is restored and the race begins. The bee starts in the top right corner and you are at the bottom left corner. Line 1330 reads the byte of memory at address 14400. This returns a value for the arrow and control keys. Lines 1340-1380 decode this into an adjustment to your present position. This routine is superior to an INKEY$ function as the keybord is constantly being strobed. As long as a key is depressed (and the action doesn't result in crossing a wall) the dot continues moving. Pressing horizontal and vertical keys simultaneously results in diagonal motion.

While the bee makes moves directly from cell to cell, you must work your way one step at a time. The bee's advantage is offset by the fact that it must perform a little dance in each cell. You get five moves for each one made by the bee. This



Example 1b. Printout with solution.

Amazed, continued...



Example 2. Completed game maze. The bee will find the only direct path from entrance to exit.

ratio makes the race very close. You probably won't win unless you make every move count—including diagonal motion where possible. Since the mazes are created randomly, some will be more difficult than others. If you find that you always lose (or win!) try changing Line 1420 to increase or decrease the number of dance steps per cell. Also the size of the maze may be decreased by changing H and V in line 2100.

Regardless of whether you win or lose, you have the option of running the same maze again.

Beemaze has been optimized for speed. "Dummy" FOR...NEXT loops are used to avoid "backward GOTOs." An example is in the K-loop of lines 530-570. This variable is never meant to reach MAX and the value of the loop counter is never used. The advantage is that when NEXT is reached, the correct line number is simply POPped off the stack. A GOTO directive requires that the ENTIRE program be searched for a match with (Line #). The end result is that Basic has much less work to do to find its new position and the program executes faster.

All REMarks are expendable and should be removed. I have indented the loops and added liberal spaces to make the listing more readable. They also slow the program down and take extra bytes. You may omit these when you key the program.

If you don't have a TRS-80 or don't intend to play the game, the lines containing the variable S1 are unnecessary as are lines 1150-1450 and 1280-2590.

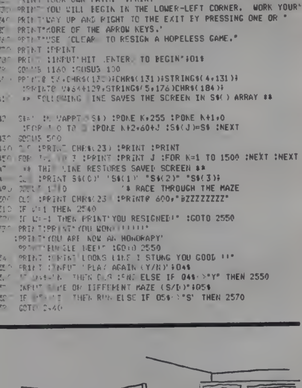
It took less than seven minutes to generate, solve and print the mazes in example 1 and 2. My ten-foot monster required a total of 2 hours and 23 minutes to complete. The average time for creating and solving the game maze on the screen (9 by 13) is about three minutes.

Mazes are more than fun and games. The algorithms presented here might be extended to control and guard robot or an automated floor-sweeper. If nothing else, just learning these techniques of array manipulation and bit-testing can be very worth your while. □

```
10 'PROGRAM ID  :        BEEMAZE
    PROGRAMMER  :        DAN ROLLINS
    DATE        :        1/20/80
20
    THIS PROGRAM CREATES AND SOLVES A MAZE OF HEXAGONAL CELLS.
    IT INCLUDES OPTIONS FOR LINEPRINTER OR SCREEN OUTPUT.
    LINEPRINT THE MAZE WITH OR WITHOUT THE SOLUTION.
    THE SCREEN OUTPUT INCLUDES A RACE THROUGH THE MAZE.

30 CLEAR 1200 :DEFINT B-Z
40 GOTO 2000
90
     *** MAZE GENERATION ROUTINE ***
100  DIM M(H,V),B((H+1)*(V+1))    '* MAZE ARRAY & BEST-ROUTE LIST
110  C=(H+1)*(V+1) :X=0 :Y=RND(V) :MAX=32765
120  FOR J=1 TO C-1
130   FOR K=0 TO MAX
140     Q=0 :Z=-((Y AND 1)=1) :ZX=X+Z
150     IF Y>1 IF M(X,Y-2)=0 THEN Q=Q+1 :T(Q)=0                '*N
160     IF Y>0 IF ZX>0 IF M(ZX-1,Y-1)=0 THEN Q=Q+1 :T(Q)=1  '*NW
170     IF Y<V IF ZX>0 IF M(ZX-1,Y+1)=0 THEN Q=Q+1 :T(Q)=2  '*SW
180     IF Y<V-1 IF M(X,Y+2)=0 THEN Q=Q+1 :T(Q)=3           '*S
190     IF Y<V IF ZX<H+1 IF M(ZX,Y+1)=0 THEN Q=Q+1 :T(Q)=4  '*SE
200     IF Y>0 IF ZX<H+1 IF M(ZX,Y-1)=0 THEN Q=Q+1 :T(Q)=5  '*NE
210     IF Q>0  THEN K=MAX :GOTO 270
      ** NO MOVE SO SCAN FOR OPEN CELL **
230     FOR L=0 TO MAX
240       Y=Y+1 :IF Y>V THEN Y=0 :X=X+1 :IF X>H THEN X=0
250       IF M(X,Y)>0 THEN L=MAX
260     NEXT L
270   NEXT K
280   IF S1 THEN X1=X*12+Z*6+3 :Y1=Y*3+2
290    ** ADJUST POINTERS, UPDATE ARRAY AND SCREEN **

300   ON T(RND(Q))+1 GOTO 310,340,370,400,430,460
310   M(X,Y)=M(X,Y)+1 :Y=Y-2 :M(X,Y)=M(X,Y)+3                  '* N
320   IF S1 THEN RESET(X1+2,Y1-1) :RESET(X1+3,Y1-1)
330 NEXT J :RETURN
340   M(X,Y)=M(X,Y)+2 :X=ZX-1 :Y=Y-1 :M(X,Y)=M(X,Y)+16         '* NW
350   IF S1 THEN RESET(X1,Y1) :RESET(X1-1,Y1+1)
360 NEXT J :RETURN
370   M(X,Y)=M(X,Y)+4 :X=ZX-1 :Y=Y+1 :M(X,Y)=M(X,Y)+32         '* SW
380   IF S1 THEN RESET(X1,Y1+4) :RESET(X1-1,Y1+3)
390 NEXT J :RETURN
400   M(X,Y)=M(X,Y)+8 :Y=Y+2 :M(X,Y)=M(X,Y)+1                  '* S
410   IF S1 THEN RESET(X1+2,Y1+5) :RESET(X1+3,Y1+5)
420 NEXT J :RETURN
430   M(X,Y)=M(X,Y)+16 :X=ZX :Y=Y+1 :M(X,Y)=M(X,Y)+2           '* SE
440   IF S1 THEN RESET(X1+5,Y1+4) :RESET(X1+6,Y1+3)
450 NEXT J :RETURN
460   M(X,Y)=M(X,Y)+32 :X=ZX :Y=Y-1 :M(X,Y)=M(X,Y)+4           '* NE
470   IF S1 THEN RESET(X1+5,Y1) :RESET(X1+6,Y1+1)
480 NEXT J :RETURN
490
     *** BUZZ THE MAZE FOR SOLUTION ***
500 A$=STRING$(2,173) :B$=STRING$(2,158)
510 Y=V :X=0 :Z=1 :PTR=0 :B(0)=20*Y :A=LOG(2) :Q=M(X,Y)
520 IF Q AND 2 THEN D=1 ELSE IF Q AND 1 THEN D=0 ELSE D=5
530 FOR K=0 TO MAX
540    Z=-((Y AND 1)=1)
550    IF S1 THEN P=Y*64+X*6+Z*3+66 :PRINT@ P,A$;
       :FOR J=0 TO 30 :NEXT :PRINT@ P,B$;
       :FOR J=0 TO 30 :NEXT :PRINT@ P,"  ";       '*BLINKER
560    IF Y=H IF X=0 THEN K=MAX :GOTO 750         '*GO IF FINISHED
570    ON D+1 GOTO 580,590,600,610,620,630
580    Y=Y-2 :GOTO 640                             '* N
590    X=X+Z-1 :Y=Y-1 :GOTO 640                    '* NW
600    X=X+Z-1 :Y=Y+1 :GOTO 640                    '* SW
610    Y=Y+2 :GOTO 640                             '* S
620    X=X+Z :Y=Y+1 :GOTO 640                      '* SE
630    X=X+Z :Y=Y-1                                '* NE
640    PTR=PTR+1 :B(PTR)=Y*20+X
650    D=D+3 :IF D>5 THEN D=D-6
660    IF M(X,Y)=2^D THEN NEXT K                 '*IF CUL-DE-SAC
670    Q=M(X,Y)-2^D :AA=LOG(Q)/A
       :IF AA=INT(AA) THEN D=AA :NEXT K          '*IF ONLY 2 DOORS
690    FOR J=0 TO 5                              '*MULTIPLE DOORS
695      D=D-1 :IF D<0 THEN D=5                  '*TURN CLOCKWISE
700      IF M(X,Y) AND (2^D)  THEN J=6           '*  UNTIL EXIT
710    NEXT J                                    '*    IS FOUND.
720    FOR J=PTR-1 TO 0 STEP -1                  '*ALSO UPDATE
730      IF B(J)=B(PTR) THEN PTR=J :J=-1         '* BEST-ROUTE
```

Amazed, continued...

```
740     NEXT J                                         '*    LIST.
750  NEXT K :RETURN
760 '
      *** ROUTINE MARKS BEST ROUTE FOR PRINTOUT ***
770  FOR J=PTR TO 0 STEP -1
780    Y=INT(B(J)/20) :X=B(J)-Y*20
790    M(X,Y)=M(X,Y)+64                             '* MARKER ON CELL
800    IF X=0 IF Y=V THEN J=-1                      '* EXIT LOOP
810  NEXT J :RETURN
820 '
      *** SEND COMPLETED MAZE TO THE PRINTER ***
830  A$='      ' :FS$="/" :BS$=CHR$(92)        '** BS$ IS BACKSLASH
840  P$(0,1)= "    --" :P$(2,3)=P$(0,1) :PE$(1)= "   >"
850  P$(1,1)= "      " :P$(3,3)=P$(1,1) :PE$(2)= " "+FS$
860  P$(2,1)= "      " :P$(0,3)=P$(2,1) :PE$(3)= "<"
870  P$(3,1)= "    **" :P$(1,3)=P$(3,1) :PE$(4)= " "+BS$
880  P$(0,2)= " "+FS$+"    " :P$(2,4)=P$(0,2)
890  P$(2,2)= " "+BS$+"    " :P$(0,4)=P$(2,2)
900  P$(1,2)=A$ :P$(3,2)=A$ :P$(1,4)=A$ :P$(3,4)=A$
910  RESTORE :FOR J=1 TO 8 :READ T(J) :NEXT
920  DATA  1,  2, 64,  4, 64, 32,  1, 16
930 '
940  FOR K=0 TO H-1 :LPRINT'   ****    "; :NEXT
950  LPRINT P$(2,2);P$(0,2)
960  FOR J=0 TO V STEP 2
970     FOR L=1 TO 4
980        IF J=0 AND L=1 THEN L=2
990        IF L=1 THEN R=-1 ELSE IF L=3 THEN R=1 ELSE R=0
1000       FOR K=0 TO H :A=0 :B=2
1010           IF M(K,J) AND T(L) THEN A=1
1020           IF M(K,J+R) AND T(L+4) THEN B=3
1030           LPRINT P$(A,L); P$(B,L);
1040       NEXT K :IF J=0 AND L=2 LPRINT" " ELSE LPRINT PE$(L)
1050    NEXT L
1060 NEXT J
1070 FOR K=0 TO H
1080    IF M(K,V) AND 64 THEN B=3 ELSE B=2
1090    LPRINT P$(0,1); P$(B,1);
1100 NEXT K :LPRINT PE$(1) :LPRINT A$;
1110 FOR K=0 TO H-1 :LPRINT P$(2,2); P$(0,2); :NEXT
1120 LPRINT P$(2,2)PE$(2) :LPRINT A$; P$(0,2); P$(2,2);
1130 FOR K=1 TO H :LPRINT"   ****    "; :NEXT :LPRINT" "
1140 RETURN
1150 '
       *** DRAW HONEYCOMB ON SCREEN ***
1160 CLS
1170 W$=CHR$(131) :DB$=CHR$(29)+CHR$(26) :A$=CHR$(143)
     :A1$=CHR$(140) :A2$=CHR$(188)
1180 FOR K=0 TO 9 :PRINT W$W$A$A$W$W$;:NEXT :PRINT W$W$W$DB$;
1190 FOR J=0 TO V :PRINT W$;
1200    IF J AND 1 THEN PRINT W$A1$A1$;
1210    FOR K=0 TO 9
1220       PRINTCHR$(145)"  "CHR$(162)A1$A1$; :NEXT
1230    IF J AND 1 THEN PRINT CHR$(8)CHR$(8)W$; ELSE PRINT W$W$;
1240    PRINT DB$;
1250 NEXT :PRINTW$W$W$;
1260 FOR K=0 TO 9 :PRINT W$W$A2$A2$W$W$; :NEXT :PRINTDB$;
1270 FOR K=69 TO 127 STEP 6
1280    PRINT@ K,A$A$; :PRINT@ K+64*V-3,A2$A2$;
1290 NEXT :RETURN
1300 '
    *** GAME ROUTINE.  PLAYER RACES BEE THROUGH MAZE ***
1310 X=3 :Y=V*3+6 :C=PTR+1 :W=0 :AR=14400 :J=0 :PX=H :PY=0
1320 B$(0)="  " :B$(1)=A$ :B$(2)=CHR$(175)+CHR$(172)
     :B$(3)=CHR$(142)+CHR$(190) :B$(4)=B$
1330 K=PEEK(AR) :X1=0 :Y1=0
     :RESET(X,Y) :RESET(X+1,Y+1) :RESET(X,Y+1) :RESET(X+1,Y)
1340    IF K AND 8 THEN Y1=-1                 '* UP ARROW
1350    IF K AND 16 THEN Y1=1                 '* DN ARROW
1360    IF K AND 32 THEN X1=-2                '* LEFT ARROW
1370    IF K AND 64 THEN X1=2                 '* RIGHT ARROW
1380    IF K=2 THEN W=-1 :RETURN              '*<CLEAR> TO RESIGN
1390    X2=X+X1 :Y2=Y+Y1 :IF POINT(X2,Y2) OR POINT (X2+1,Y2)
        OR POINT(X2+1,Y2+1) OR POINT(X2,Y2+1) THEN 1410
1400    X=X2 :Y=Y2
1410    SET(X,Y) :SET(X+1,Y+1) :SET(X,Y+1) :SET(X+1,Y)
1420    J=J-1 :IF J<0 THEN J=4 :C=C-1
        :IF PX=0 AND PY=V THEN W=1 :RETURN
         ELSE PY=INT(B(C)/20) :PX=B(C)-PY*20
        :P=PY*64+PX*6+66 -((PY AND 1)=1)*3     '* MOVE THE BEE
1430    PRINT@ P,B$(J);
1440    IF X>120 IF Y<4 THEN RETURN           '*PLAYER WINS
1450 GOTO 1330
1990 '
      ** PRINT INSTRUCTIONS AND SET UP MAZE DIMENSIONS **
2000 CLS
2010 PRINT@ 72,"BEE AMAZED  --  PROGRAMMED BY DAN ROLLINS"
2020 PRINT :PRINT"THIS PROGRAM CREATES A MAZE WHICH IS"
2030 PRINT"COMPRISED OF HEXAGONAL CELLS, SIMILAR TO A HONEYCOMB."
2040 PRINT"YOU MAY SEND THE MAZE DIRECTLY TO YOUR PRINTER"
2050 PRINT"(SOLUTION OPTIONAL)" :PRINT"                        OR"
2060 PRINT"WATCH AS THE MAZE IS CREATED AND SOLVED ON YOUR"
2070 PRINT"SCREEN, THEN RACE THE BEE THROUGH THE MAZE."
2080 PRINT : INPUT"PRINT THE MAZE OR RACE THE BEE (P/R)";O1$
2090 IF O1$="R" THEN S1=1 ELSE IF O1$<>"P" THEN 2080
2100 IF S1 THEN V=13 :H=9  :GOTO 2280
2110 '** GET INPUT FOR PRINTER OPTION **
2120 CLS :PRINT :INPUT"HEIGHT OF MAZE ";V :V=INT(V/2)*2-1
2130 PRINT :INPUT"WIDTH OF THE MAZE ";H
2140 PRINT"CREATING THE MAZE......PLEASE BE PATIENT."
2150 GOSUB 100            '* CREATE MAZE
2160 PRINT"SOLVING THE MAZE" :GOSUB 500
2170 PRINT"YOU MAY PRINT THE MAZE AS MANY TIMES AS DESIRED"
2180 PRINT"BUT AFTER ONE PRINTOUT WITH THE SOLUTION, ALL "
2190 PRINT"THE FOLLOWING PRINTOUTS WILL BE SOLVED." :PRINT
2200 INPUT"READY PRINTER........... HIT <ENTER>";Q2$ :PRINT
2210 INPUT"DO YOU WANT THE SOLUTION ON THIS PRINTOUT (Y/N)";Q2$
2220 IF Q2$="Y" THEN GOSUB 770 ELSE IF Q2$<>"N" THEN 2210
2230 GOSUB 830                '* LINEPRINT ROUTINE
2240 INPUT "SAME OR DIFFERENT MAZE (S/D)  ";Q3$
2250 IF Q3$="D" THEN RUN ELSE IF Q3$<>"S" THEN 2240
2260 GOTO 2210
2270 '** INSTRUCTIONS FOR THE RACE **

2280 CLS :PRINT :PRINT"   RELAX AND WATCH AS A UNIQUE MAZE"
2290 PRINT"DEVELOPES ON YOUR SCREEN.  WHEN THE FLASHING 'BEE'"
2300 PRINT"APPEARS, THE MAZE IS COMPLETE AND THE SHORTEST"
2310 PRINT"ROUTE IS BEING DETERMINED. USE THIS TIME TO PLAN"
2320 PRINT"YOUR OWN PATH." :PRINT
2330 PRINT"YOU WILL BEGIN IN THE LOWER-LEFT CORNER.  WORK YOUR"
2340 PRINT"WAY UP AND RIGHT TO THE EXIT BY PRESSING ONE OR "
2350 PRINT"MORE OF THE ARROW KEYS."
2360 PRINT"USE <CLEAR> TO RESIGN A HOPELESS GAME."
2370 PRINT :PRINT
2380 PRINT :INPUT"HIT <ENTER> TO BEGIN";O1$
2390 GOSUB 1160 :GOSUB 100
2400 PRINT@ 56,CHR$(130);CHR$(131);STRING$(4,131);
     :PRINT@ V*64+129,STRING$(5,176)CHR$(184);
2410 '** FOLLOWING LINE SAVES THE SCREEN IN S$() ARRAY **

2420 S$="" :K=VARPTR(S$) :POKE K,255 :POKE K+1,0
     :FOR J=0 TO 3 :POKE K+2,60+J :S$(J)=S$ :NEXT
2430 GOSUB 500
2440 CLS :PRINT CHR$(23) :PRINT :PRINT
2450 FOR J=1 TO 3 :PRINT :PRINT J :FOR K=1 TO 1500 :NEXT :NEXT
2460 '** THIS LINE RESTORES SAVED SCREEN **
2470 CLS :PRINT S$(0)"S$(1)"S$(2)"S$(3);
2490 GOSUB 1310            '* RACE THROUGH THE MAZE
2500 CLS :PRINT CHR$(23) :PRINT@ 600,"BZZZZZZZZ"
2510 IF W=1 THEN 2540
2520 IF W=-1 THEN PRINT"YOU RESIGNED!" :GOTO 2550
2530 PRINT:PRINT"YOU WON!!!!!!"
     :PRINT"YOU ARE NOW AN HONORARY"
     :PRINT"BUMBLE BEE!" :GOTO 2550
2540 PRINT :PRINT"LOOKS LIKE I STUNG YOU GOOD !!"
2550 PRINT :INPUT "PLAY AGAIN (Y/N)";O4$
2560 IF O4$="N" THEN CLS :END ELSE IF O4$<>"Y" THEN 2550
2570 INPUT"SAME OR DIFFERENT MAZE (S/D)";O5$
2580 IF O5$="D" THEN RUN ELSE IF O5$<>"S" THEN 2570
2590 GOTO 2440
```



"It's the repair technician."

You and your Apple can have a new view of the world.

Dithertizer!

Lynn Busby, president of the Computer Station, as seen by the Dithertizer II.

Dithering. Developed at Bell Labs and MIT, dithering was originally an approach to picture transmission. Compared to other methods, dithering is fast and accurate.

The Dithertizer II was designed for the Apple computer by David K. Hudson, a researcher at MIT. Design goals were high accuracy, fast scanning, maximum reliability and an economical price.

High Quality Images

The resolution is of the Dithertizer is the maximum the Apple can handle in the high-resolution mode, i.e., 280 x 192 (53,760) pixels.

To produce an image, a video camera is focused on the subject. Peripherals Plus furnishes a Sanyo VC161OX camera, a laboratory/industrial unit with an f 1.6 lens. This camera has a focus range of 18" (for extreme close ups) to infinity (for distant subjects).

The camera scans an entire frame in 1/60th of a second. Two frames are scanned, of course, in 1/30th of a second. By adjusting the blackness control (with Paddle 0) to any one of 255 levels you can determine the threshold of gray between the two frames.

A 1/30th second, two-frame scan has two levels of gray and produces a high-contrast but quite recognizable image

Pictures or Contours

Using the "Contour" software routines and contrast control (Paddle 1), it is possible to subtract one image from another. If the blackness thresholds of the two images are close, say 125 and 127, the resulting image will show just the outlines or highlights of an object.

Another possibility is to reduce the contrast to zero which results in a nearly blank screen except for movement in the area scanned. This type of movement detector is much faster (1/30th second) and more precise than other much more expensve systems. It is currently being used to detect and record movement of laboratory animals. It is also used in security installations.

The "Dithering" software routines use the contrast control to divide an image into gray tones. As mentioned above, two levels (usually white and black) result in a high contrast image. Four gray levels provide additional definition while sixteen levels produce a highly detailed image in just over 1/4th of a second. Extremely high detail is possible using the highest 64-gray level setting. At this level, an image is produced in 64/60ths of a second or just over one second. The quality of this image is close to that of a halftone photograph found in a newspaper or magazine.

Using Dithered Images

What can one do with a dithered image? Upon completion it can be stored automatically in either page 1 or 2 of the high-resolution graphics area of the Apple. Hence, it can be printed out on practically any printer. To print it on an Apple Silentype printer or equivalent requires no additional software.

To take advantage of the automatic print routines in the Dithertizer itself does require additional software tailored to a specific printer. Software packages are available at $44.95 each for the following printers: IDS 440, 445, 460, and 560; IP225; Anadex DP9500 and DP9501; Spinwriter 5510 and 5520.

Individual images or series of images may also be incorporated in other programs in the same way that other hi-res graphics are used. Using VersaWriter software, for example, text may be added to images. An image may be shown on the screen while a disk is loading or while the computer is completing a time-consuming calculation in another program.

With the proper software, the Dithertizer can be used to perform image enhancement, to identify features, detect motion, track a moving target or create a detailed picture for display. The possibilities are limited only by your imagination.

Quality Construction

The dithertizer is manufactured to exacting specifications by Computer Station. It consists of the Dithertizer II board which plugs into Slot 7 in the Apple II, a cable which connects between the Dithertizer and motherboard and a 10 foot cable to the camera. The system requires a 48K Apple disk system.

The software package consists of three routines on disk: "Dither" to build a gray scale picture, "Contour" to produce an edge scan using image subtraction, and "Dscan" to store a binary image in either page 1 or 2 of the high-resolution graphics area.

Peripherals Plus also includes a Sanyo VC161OX video camera with external horizontal and vertical sync input.

The components of the packge—hardware, software and camera—are warranteed by the manufacturers against defects in material and workmanship for 90 days. In addition, Peripherals Plus guarantees that if you are not completely satisfied you may return the system for a prompt and courteous refund.

Order Today

The entire Dithertizer system consisting of the Dithertizer board, Sanyo camera, cables and software costs only $650 plus $6 shipping and handling in the continental United States. Customers in other loctions should write for shipping rates. Price for the board and software alone is $300 while the camera alone is $410. To order your system, send payment or Visa, MasterCard or American Express card number and expiration date to the adress below. Credit card customers may also call orders to our toll-free number.

Don't put it off. Remember, your system is backed by both manufacturer warranties and a complete moneyback guarantee of satisfaction from Peripherals Plus.

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(In NJ 201-540-0445)

OSI TIGER

Kerry Lourash

Here's a machine language routine that enables the OSI C1P and C2P to use the graphic mode of the Paper Tiger printer. A "reverse print" option and capability for user-definable characters are included.

When I saw Bob Stuckmeyer's article (*Creative Computing* January 1981) on implementing the Paper Tiger graphic mode for the Sorcerer, I immediately thought of my friend, George, who has an OSI Super II and a Tiger. Although he had the graphic option, it was unused because there was no graphic program available for OSI. Unfortunately, Stuckmeyer's program was not much help, since it was written for the Z-80. I *would* like to thank him for the concept of making four passes to print three screen lines, however.

The OSI Tiger (Listing 1) is set up as a subroutine, so it can be called by a USR command. Output is routed to the ACIA for serial output. If you use parallel interfacing, change the OUTPUT label to your own output routine.

Kerry Lourash, 1220 North Dennis, Decatur, IL 62522.

```
10 0000            SCN=$40    ;ADDRESS OF CHAR. CONVERTED
20 0000            SCN2=$42   ;ADDR. OF CHAR ABOVE CURRENT CHAR
30 0000            INDEX=$44  ;OFFSET ADDED TO TABLE
40 0000            CHAR=$46   ;WORK AREA TO CONVERT ELEMENTS
50 0000            PASS=$48   ;PASS COUNTER(1-4)
60 0000            LINE=$49   ;LINE(PRINTER)COUNTER
70 0000            BYTE=$4A   ;ELEMENT COUNTER(1-8)
80 0000            COL=$4B    ;COLUMN COUNTER
90 0000            INV=$4C    ;INVERSE PRINT FLAG
100 0000           OUTPUT=$BF15 ;ACIA OUTPUT SUB(C2P)
110 36E9           *=$36E9
120 36E9 A980             LDA #$80     ;SET SCREEN COUNTERS
130 36EB 8540             STA SCN
140 36ED A9D0             LDA #$D0
150 36EF 8541             STA SCN+1
160 36F1 A940             LDA #$40
170 36F3 8542             STA SCN2
175 36F5 A9D0             LDA #$D0
180 36F7 8543             STA SCN2+1
190 36F9 A903             LDA #3      ;ENTER GRAPHIC MODE
200 36FB 2015BF           JSR OUTPUT
210 36FE 2015BF           JSR OUTPUT ;SET CHAR WIDTH
220 3701 A91E             LDA #$1E
230 3703 2015BF           JSR OUTPUT
240 3706 20F337           JSR VTAB     ;VERTICAL TAB
250 3709 A928             LDA #$28     ;SET LINE CNTR.
260 370B 8549             STA LINE
270 370D A901      S0     LDA #1       ;SET PASS CNTR.
280 370F 8548             STA PASS
290 3711 A940      S1     LDA #$40     ;SET COLUMN CNTR.
300 3713 854B             STA COL
310 3715 A900      S2     LDA #0      ;ZERO ELEMENT CNTR.
320 3717 854A             STA BYTE
330 3719 206437    S3     JSR CNVT    ;CONVERT 1 ELEMENT & PRINT
340 371C E64A             INC BYTE    ;INCREMENT ELEMENT CNTR.
350 371E A54A             LDA BYTE
360 3720 C908             CMP #8      ;IS IT>7?
370 3722 30F5             BMI S3      ;NO,FIND & PRINT NEXT ELEMENT
380 3724 E640             INC SCN     ;YES,INCREMENT SCREEN CNTRS
390 3726 D002             BNE S4
400 3728 E641             INC SCN+1
410 372A E642      S4     INC SCN2
420 372C D002             BNE S5
430 372E E643             INC SCN2+1
440 3730 C64B      S5     DEC COL    ;DECREMENT COLUMN CNTR
450 3732 D0E1             BNE S2     ;IF LINE NOT DONE,TO S2
460 3734 20F337           JSR VTAB   ;PRINT HEAD TO START OF LINE
470 3737 C649             DEC LINE   ;NEXT LINE
480 3739 F01F             BEQ EXIT   ;IF LINES DONE,EXIT
490 373B E648             INC PASS   ;INCREMENT PASS COUNTER
500 373D A448             LDY PASS
510 373F C004             CPY #4
520 3741 F004             BEQ M0     ;IF PASS=4,TO M0
530 3743 10C8             BPL S0     ;IF PASS>4,TO S0
540 3745 30CA             BMI S1     ;IF PASS<4,TO S1
550 3747 A202      M0     LDX #2
560 3749 38        M1     SEC        ;SUBTRACT 1 LINE FROM SCREEN CNT
570 374A B540             LDA SCN,X
580 374C E940             SBC #$40
590 374E 9540             STA SCN,X
```

Listing 1.

A picture created for one of George's kids (by George).

Tiger, continued...

```
 600 3750 B002              BCS M2
 610 3752 D641              DEC SCN+1,X
 620 3754 CA        M2      DEX
 630 3755 CA                DEX
 640 3756 F0F1              BEO M1
 650 3758 D0B7              BNE SI
 660 375A A903      EXIT    LDA #3      ;EXIT GRAPHIC MODE
 670 375C 2015BF            JSR OUTPUT
 680 375F A902              LDA #2
 690 3761 4C15BF            JMP OUTPUT ;EXIT ROUTINE
 700 3764 A540      CNVT    LDA SCN     ;END OF ROW?
 710 3766 293F              AND #$3F
 720 3768 38                SEC
 730 3769 E902              SBC #2
 740 376B C540              CMP SCN
 750 376D 1001              BPL CO
 760 376F 60                RTS         ;YES, TO MAIN ROUTINE
 770 3770 20BB37    CO      JSR FIND    ;FIND ELEMENT IN TABLE
 780 3773 8546      P4      STA CHAR    ;PUT ELEMENT IN WORKSPACE
 790 3775 A204              LDX #4
 800 3777 E448              CPX PASS    ;PASS 4?
 810 3779 D005              BNE P3      ;NO, TRY PASS 3
 820 377B 4A                LSR A
 830 377C 4A                LSR A
 840 377D 4CA937            JMP OUT
 850 3780 CA        P3      DEX
 860 3781 E448              CPX PASS    ;PASS 3?
 870 3783 D011              BNE P2      ;NO,TRY PASS 2
 880 3785 20E937            JSR ABOVE
 890 3788 A004              LDY #4
 900 378A 6646      C1      ROR CHAR
 910 378C 6647              ROR CHAR+1
 920 378E 88                DEY
 930 378F D0F9              BNE C1
 940 3791 A547              LDA CHAR+1
 950 3793 4CA937            JMP OUT
 960 3796 CA        P2      DEX
 970 3797 E448              CPX PASS    ;PASS 2?
 980 3799 D00E              BNE OUT     ;NO,TO PASS 1 & OUTPUT
 990 379B 20E937            JSR ABOVE
1000 379E A002              LDY #2
1010 37A0 0647      C2      ASL CHAR+1
1020 37A2 2646              ROL CHAR
1030 37A4 88                DEY
1040 37A5 D0F9              BNE C2
1050 37A7 A546              LDA CHAR
1060 37A9 A64C      OUT     LDX $4C     ;CHECK INVERSE FLAG
1070 37AB D002              BNE OUT1
1080 37AD 493F              EOR #$3F    ;INVERT ELEMENT
1090 37AF 293F      OUT1    AND #$3F    ;ZERO BIT 6&7 OF ELEMENT
1100 37B1 C903              CMP #3      ;IF ELEMENT=3,OUTPUT TWICE
1110 37B3 D003              BNE OUT2
1120 37B5 2015BF            JSR OUTPUT
1130 37B8 4C15BF    OUT2    JMP OUTPUT ;PRINT ELEMENT & RETURN
1140 37BB A000      FIND    LDY #0      ;FIND ELEMENT IN TABLE
1150 37BD B140              LDA (SCN),Y ;GET SCREEN CHAR.
1160 37BF 8445      F1      STY INDEX+1
1170 37C1 8544              STA INDEX
1180 37C3 A003              LDY #3      ;MULTIPLY BY 8
1190 37C5 0644      F2      ASL INDEX
1200 37C7 2645              ROL INDEX+1
1210 37C9 88                DEY
1220 37CA D0F9              BNE F2
1230 37CC 18                CLC         ;ADD INDEX TO TABLE
1240 37CD A544              LDA INDEX
1250 37CF 69FE              ADC #TABL#256/256
1260 37D1 8544              STA INDEX
1270 37D3 A545              LDA INDEX+1
1280 37D5 6937              ADC #TABL/256
1290 37D7 8545              STA INDEX+1
1300 37D9 18                CLC         ;ADD ELEMENT No. TO TABLE
1310 37DA A544              LDA INDEX
1320 37DC 654A              ADC BYTE
1330 37DE 8544              STA INDEX
1340 37E0 9002              BCC F3
1350 37E2 E645              INC INDEX+1
1360 37E4 A000      F3      LDY #0
1370 37E6 B144              LDA (INDEX),Y ;GET ELEMENT
1380 37E8 60                RTS
1390 37E9 A000      ABOVE   LDY #0      ;FIND ELEMENT OF CHAR.
1400 37EB B142              LDA (SCN2),Y ;1 LINE ABOVE CHAR.
1410 37ED 20BF37            JSR F1
1420 37F0 8547              STA CHAR+1
1430 37F2 60                RTS
1440 37F3 A903      VTAB    LDA #3      ;PRINT HEAD TO START OF LINE
1450 37F5 2015BF            JSR OUTPUT
1460 37F8 A90B              LDA #$B
1470 37FA 2015BF            JSR OUTPUT
1480 37FD 60                RTS
1490 37FE                   ;DATA FOR CHAR. #0
1500 37FE 00        TABL .BYTE 0,$E7,$42,$FF,$FF,$42,$E7,0
1500 37FF E7
1500 3800 42
1500 3801 FF
1500 3802 FF
1500 3803 42
1500 3804 E7
1500 3805 00
```

Table 1.

```
*
:837FE,3FFE
```

	E	F	0	1	2	3	4	5	6	7	8	9	A	B	C	D
37FE	00	E7	42	FF	FF	42	E7	00	00	E7	42	7E	7E	42	E7	00
380E	81	42	3C	00	00	3C	42	81	81	42	24	24	24	24	42	81
381E	50	60	48	70	70	48	60	50	00	40	E0	E0	E0	E0	F8	F9
382E	FF	F8	F0	E0	E0	E0	F0	70	70	F0	E0	E0	E0	F0	F8	FF
383E	F9	F8	E0	E0	E0	E0	40	00	00	04	04	24	24	7C	64	64
384E	70	78	78	6C	6C	08	00	08	08	08	08	6C	6C	78	78	70
385E	64	64	7C	24	24	04	04	00	00	1C	3E	3F	FF	3E	1C	08
386E	00	F0	38	FC	8C	F8	F0	00	F8	2C	FE	AF	FF	FE	AC	FE
387E	00	04	82	FF	FF	82	04	00	10	20	70	B8	1D	0F	07	0F
388E	3C	18	18	18	18	5A	3C	18	08	04	0E	18	B8	F0	E0	F0
389E	00	20	41	FF	FF	41	20	00	F0	E0	F0	B8	1D	0E	04	08
38AE	18	3C	5A	18	18	18	18	3C	0F	07	0F	1D	B8	70	20	10
38BE	00	04	0A	0A	7E	0A	7E	00	00	30	10	10	10	10	18	00
38CE	00	10	7E	52	7E	10	00	00	00	00	7E	42	7E	00	00	00
38DE	00	22	72	FA	02	02	3E	00	88	44	22	11	11	22	44	88
38EE	00	06	0A	F2	F2	0A	06	00	11	22	44	88	88	44	22	11
38FE	00	00	00	00	00	00	00	00	00	00	00	5F	00	00	00	00
390E	00	00	07	00	07	00	00	00	00	14	7F	14	7F	14	00	00
391E	00	24	2A	7F	2A	12	00	00	00	23	13	08	64	62	00	00
392E	00	36	49	56	20	50	00	00	00	00	00	07	00	00	00	00
393E	00	1C	22	41	00	00	00	00	00	00	00	41	22	1C	00	00
394E	00	22	14	7F	14	22	00	00	00	08	08	3E	08	08	00	00
395E	00	00	40	30	00	00	00	00	00	08	08	08	08	08	00	00
396E	00	00	00	40	00	00	00	00	00	20	10	08	04	02	00	00
397E	00	3E	51	49	45	3E	00	00	00	00	42	7F	40	00	00	00
398E	00	62	51	49	49	46	00	00	00	21	41	49	4D	33	00	00
399E	00	18	14	12	7F	10	00	00	00	27	45	45	45	39	00	00
39AE	00	3C	4A	49	49	31	00	00	00	01	71	09	05	03	00	00
39BE	00	36	49	49	49	36	00	00	00	46	49	49	29	1E	00	00
39CE	00	00	00	14	00	00	00	00	00	00	40	34	00	00	00	00
39DE	00	08	14	22	41	00	00	00	00	14	14	14	14	14	00	00
39EE	00	00	41	22	14	08	00	00	00	02	01	59	05	02	00	00
39FE	00	3E	41	5D	59	4E	00	00	00	7C	12	11	12	7C	00	00
3A0E	00	7F	49	49	49	36	00	00	00	3E	41	41	41	22	00	00
3A1E	00	7F	41	41	41	3E	00	00	00	7F	49	49	49	41	00	00
3A2E	00	7F	09	09	09	01	00	00	00	3E	41	41	51	71	00	00
3A3E	00	7F	08	08	08	7F	00	00	00	00	41	7F	41	00	00	00
3A4E	00	20	40	40	40	3F	00	00	00	7F	08	14	22	41	00	00
3A5E	00	7F	40	40	40	40	00	00	00	7F	02	0C	02	7F	00	00
3A6E	00	7F	04	08	10	7F	00	00	00	3E	41	41	41	3E	00	00
3A7E	00	7F	09	09	09	06	00	00	00	3E	41	51	21	5E	00	00
3A8E	00	7F	09	19	29	46	00	00	00	26	49	49	49	32	00	00
3A9E	00	01	01	7F	01	01	00	00	00	3F	40	40	40	3F	00	00
3AAE	00	1F	20	40	20	1F	00	00	00	7F	20	18	20	7F	00	00
3ABE	00	63	14	08	14	63	00	00	00	03	04	78	04	03	00	00
3ACE	00	61	51	49	45	43	00	00	00	7F	7F	41	41	41	00	00
3ADE	00	02	04	08	10	20	00	00	00	41	41	41	7F	7F	00	00
3AEE	00	10	08	04	08	10	00	00	00	40	40	40	40	40	C0	00
3AFE	00	00	00	00	00	00	00	00	00	38	44	44	28	7C	00	00
3B0E	00	7F	28	44	44	38	00	00	00	38	44	44	44	44	00	00
3B1E	00	38	44	44	28	7F	00	00	00	38	54	54	54	18	00	00
3B2E	00	00	08	7E	09	00	00	00	00	1C	A2	A2	94	7E	00	00
3B3E	00	7F	04	04	04	78	00	00	00	00	48	7A	40	00	00	00
3B4E	00	00	80	80	7A	00	00	00	00	7F	10	18	24	42	00	00
3B5E	00	00	41	7F	40	00	00	00	00	7C	04	78	04	78	00	00
3B6E	00	7C	04	04	04	78	00	00	00	38	44	44	44	38	00	00
3B7E	00	FE	14	22	22	1C	00	00	00	1C	22	22	14	FE	00	00
3B8E	00	7C	08	04	04	00	00	00	00	48	54	54	54	24	00	00
3B9E	00	04	04	7E	04	04	00	00	00	3C	40	40	40	7C	00	00
3BAE	00	0C	30	40	30	0C	00	00	00	3C	40	20	40	3C	00	00
3BBE	00	44	28	10	28	44	00	00	00	00	BC	A0	A0	7C	00	00
3BCE	00	44	64	54	4C	44	00	00	00	00	08	36	41	41	00	00
3BDE	00	41	41	36	00	00	00	00	00	00	00	77	00	00	00	00
3BEE	00	00	00	2A	08	08	00	00	00	10	08	08	08	04	00	00
3BFE	80	80	80	80	80	80	80	80	40	40	40	40	40	40	40	40
3C0E	20	20	20	20	20	20	20	20	10	10	10	10	10	10	10	10
3C1E	08	08	08	08	08	08	08	08	04	04	04	04	04	04	04	04
3C2E	02	02	02	02	02	02	02	02	01	01	01	01	01	01	01	01
3C3E	FF	00	00	00	00	00	00	00	00	FF	00	00	00	00	00	00
3C4E	00	00	FF	00	00	00	00	00	00	00	00	FF	00	00	00	00
3C5E	00	00	00	00	FF	00	00	00	00	00	00	00	00	FF	00	00
3C6E	00	00	00	00	00	00	FF	00	00	00	00	00	00	00	00	FF
3C7E	C0	C0	C0	C0	C0	C0	C0	C0	03	03	03	03	03	03	03	03
3C8E	FF	FF	00	00	00	00	00	00	00	00	00	00	00	00	FF	FF
3C9E	18	18	18	18	18	18	18	18	00	00	00	FF	FF	00	00	00
3CAE	E0	E0	E0	E0	E0	E0	E0	E0	07	07	07	07	07	07	07	07
3CBE	FF	FF	FF	00	00	00	00	00	00	00	00	00	00	FF	FF	FF
3CCE	F0	F0	F0	F0	F0	F0	F0	F0	0F	0F	0F	0F	0F	0F	0F	0F
3CDE	FF	FF	FF	FF	00	00	00	00	00	00	00	00	FF	FF	FF	FF
3CEE	F8	F8	F8	F8	F8	F8	F8	F8	FC	FC	FC	FC	FC	FC	FC	FC
3CFE	FE	FE	FE	FE	FE	FE	FE	FE	FF	FF	FF	FF	FF	FF	FF	FF
3D0E	1F	1F	1F	1F	1F	1F	1F	1F	3F	3F	3F	3F	3F	3F	3F	3F
3D1E	7F	7F	7F	7F	7F	7F	7F	7F	00	00	00	00	F0	F0	F0	F0
3D2E	00	00	00	00	0F	0F	0F	0F	F0	F0	F0	F0	00	00	00	00
3D3E	0F	0F	0F	0F	00	00	00	00	0F	0F	0F	0F	F0	F0	F0	F0
3D4E	F0	F0	F0	F0	0F	0F	0F	0F	00	00	F0	F0	F0	F0	00	00
3D5E	00	00	0F	0F	0F	0F	00	00	00	00	00	00	3C	3C	3C	3C
3D6E	3C	3C	3C	3C	00	00	00	00	FF	7F	3F	1F	0F	07	03	01
3D7E	80	C0	E0	F0	F8	FC	FE	FF	01	03	07	0F	1F	3F	7F	FF
3D8E	FF	FE	FC	F8	F0	E0	C0	80	E0	E8	F0	F0	E0	F0	F8	FC
3D9E	FC	FF	FC	E0	F0	F0	68	20	20	68	F0	F0	E0	FC	FF	FC
3DAE	FC	F8	F0	E0	F0	F0	E8	E0	05	0A	05	0A	05	0A	05	0A
3DBE	50	A0	50	A0	50	A0	50	A0	55	AA	55	AA	00	00	00	00
3DCE	00	00	00	00	55	AA	55	AA	55	AA	55	AA	55	AA	55	AA
3DDE	81	42	24	18	18	24	42	81	80	40	20	10	08	04	02	01
3DEE	01	02	04	08	10	20	40	80	01	02	04	08	08	04	02	01
3DFE	00	00	00	00	18	24	42	81	80	40	20	10	10	20	40	80
3E0E	81	42	24	18	00	00	00	00	08	08	04	04	02	02	01	01
3E1E	80	80	40	40	20	20	10	10	01	01	02	02	04	04	08	08
3E2E	10	10	20	20	40	40	80	80	00	00	00	00	03	0C	30	C0
3E3E	03	0C	30	C0	00	00	00	00	00	00	00	00	C0	30	0C	03
3E4E	C0	30	0C	03	00	00	00	00	00	00	00	00	0F	08	08	08
3E5E	00	00	00	00	F0	10	10	10	10	10	10	F0	00	00	00	00
3E6E	08	08	08	0F	00	00	00	00	01	01	01	01	01	01	01	FF
3E7E	80	80	80	80	80	80	80	FF	FF	80	80	80	80	80	80	80
3E8E	FF	01	01	01	01	01	01	01	3E	2F	2E	3C	38	38	33	3C
3E9E	2E	2E	2E	2C	38	38	38	FE	FE	38	38	38	2C	2E	2E	2E
3EAE	3C	38	38	38	3C	2E	2F	3E	18	18	18	1F	1F	18	18	18
3EBE	00	00	00	FF	FF	18	18	18	18	18	18	F8	F8	18	18	18
3ECE	18	18	18	FF	FF	00	00	00	18	18	18	FF	FF	18	18	18
3EDE	00	00	00	00	03	04	08	08	00	00	00	00	C0	[illegible]	[illegible]	[illegible]
3EEE	10	10	20	C0	00	00	00	00	08	08	04	03	00	00	[illegible]	00
3EFE	00	00	00	00	3C	42	81	81	81	81	42	3C	00	00	00	00
3F0E	3C	42	81	81	81	81	42	3C	3C	3C	42	42	81	81	81	81
3F1E	81	81	81	81	42	42	3C	3C	0E	1F	3F	FE	FE	3F	1F	0E
3F2E	30	38	83	C7	C7	83	38	30	18	3C	9E	FF	FF	9E	3C	18
3F3E	18	3C	7E	FF	FF	7E	3C	18	E7	C3	81	00	00	81	C3	E7
3F4E	18	18	3C	3C	7E	7E	FF	FF	FF	FF	7E	7E	3C	3C	18	18
3F5E	30	38	9C	FF	FF	9C	38	30	3C	18	DB	FF	7E	3C	18	18
3F6E	0C	1C	39	FF	FF	39	1C	0C	18	18	3C	7E	FF	DB	18	3C
3F7E	00	20	90	78	90	20	00	00	00	20	90	78	D0	3C	0C	00
3F8E	00	00	00	C0	FF	F0	F0	F8	00	02	04	C8	F0	[illegible]	F8	F8
3F9E	10	10	10	00	F0	F0	F8	F8	F8	F0	F0	FF	C0	00	00	[illegible]
3FAE	F8	F8	F0	F0	C8	04	02	00	F8	F8	F0	F0	D0	10	[illegible]	[illegible]
3FBE	00	00	F8	70	7E	70	F8	00	00	20	30	F8	7C	36	14	[illegible]
3FCE	22	3E	3E	3E	2A	08	08	00	00	04	CC	[illegible]	3E	[illegible]	[illegible]	[illegible]
3FDE	00	00	1F	0E	7E	0E	1F	00	00	40	28	[illegible]	3E	1F	[illegible]	[illegible]
3FEE	00	00	08	2A	3E	3E	3E	[illegible]	02	[illegible]	38	[illegible]	F8	[illegible]	[illegible]	[illegible]

Tiger, continued...

Listing 2. OSI Tiger data conversion.

```
ADDRESS CODE     MNEMONICS

1000  A900       LDA #0
   2  8530       STA $30
   4  A008       LDY #8
   6  A207       LDX #7
   8  5EXXXX     LSR ORIGIN.X: data start add. (reset after every use)
   B  2EYYYY     ROL TABLE: table start add. (reset after use)
   E  CA         DEX
   F  10F7       BPL $1008
1011  EEOC10     INC TABLE
   4  D003       BNE $1019
   6  EEOD10     INC TABLE+1
   9  88         DEY
   A  DOEA       BNE $1006
   C  18         CLC
   D  AD0910     LDA ORIGIN
1020  6908       ADC #8
   2  8D0910     STA ORIGIN
   5  9003       BCC $102A
   7  EEOA10     INC ORIGIN+1
   A  C630       DEC $30
   C  DOD6       BNE $1004
102E  4COOFE     JMP $FE00: exit to monitor
```

Basically, the OSI Tiger gets a character from the video memory, multiplies its value by eight, and uses this value to find the correct byte in a look-up table. This table (see Table 1) consists of groups of eight bytes. Each group defines one OSI character. Since there are 256 characters, the table occupies 2K bytes of memory. After the byte is found, it is converted to the correct form and output to the printer.

Passes two and three use the character directly above the current character to produce printer data. To make things simple, I use two screen position counters, SCN and SCN2. The zero-page addresses used are located in the input buffer area ($13-$5A). Basic won't be using these addresses while the routine is running. Location $4C(dec 76) controls the "inverse print" mode. If $4C contains a zero, the Tiger prints a reverse image.

Line 220 sets the print size (#$1E) at 12 characters per inch. Even at this small print size, the Tiger prints only 62 of the 64 characters in the C2P video line. At ten c.p.i.(#$1D), the Tiger will print 52 characters per line. To use this print size, you must also change line 730 to SBC #$C. At 8.3 c.p.i., the Tiger will print 43 characters per line. Change line 730 to SBC #$15. If you wish to use the 32 characters per line option of the C2P, change line 220 to LDA #$1C and line 730 to SBC #$20.

To convert the routine to C1P operation:

Change line 100 to OUTPUT = $FCB1
Change line 120 to LDA #$40
Change line 140 to LDA #$20
Change line 220 to LDA #$1C
Change line 290 to LDA #$20
Change line 580 to SBC #$20
Delete lines 700 to 760 or;
Change line 710 to AND #$1F
Change line 730 to SBC #0

To make the number of passes come out even, only the bottom 30 lines of the video display are printed. If you want to print the whole screen, a reasonable approximation can be had by setting SCN to $D000 and SCN2 to $EFE0 or $EFC0. Also, change line 250 to LDA #$2A or LDA #$2B.

The printer must be carefully adjusted to minimize distortion of the picture. See the user's manual for directions. I've also read that using heavy weight paper lessens distortion.

There's one big problem in implementing the OSI Tiger: generating the data table. The data in the character generator ROM can't be addressed as memory, so a data table in RAM must be created. To do this, George breadboarded a circuit to read the character generator chip as a section of memory at $E000. I provided a character generator chip from my C1P. Using the OSI Extended Monitor, we transferred the data from the ROM to a section of RAM. Now we had one more problem. The data bytes were intended for use with the CRT, which scans one horizontal row of each character at a time, as opposed to the printer, which prints one vertical column at a time. I designed a routine to convert the ROM data to printer formatted data (see Listing 2).

With the character data in RAM, you can change any character, although you won't be able to see the character on-screen. If you have access to an EPROM burner, you can change the data in the ROM and then convert it to printer data with Listing 2. For a dump of the complete table or the ROM data (please specify), send a cassette and return postage to me at the address listed at the beginning of this article. □

Creative Computing-- Albert Einstein in black on a red denim-look shirt with red neckband and cuffs.

Creative's own outrageous **Bionic Toad** in dark blue on a light blue shirt for kids and adults.

Plotter display of **PI to 625 Places** in dark brown on a tan shirt.

I'd rather be playing spacewar-- black with white spaceships and lettering.

Give your tie a rest!

All T-shirts are available in adult sizes S,M,L,XL. Bionic Toad, Program Bug and Spacewar also available in children's sizes S(6-8), M(10-12) and L(14-16). Made in USA. $6.00 each plus 75¢ shipping.

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Crash Cursor and Sync from the comic strip in SYNC magazine emblazoned in white on this black shirt.

Computer Bum-- black design by cartoonist Monte Wolverton on gray denim-look shirt with black neckband and cuffs.

The **Program Bug** that terrorized Cybernia in Katie and the Computer is back on this beige t-shirt with purple design. You can share the little monster with your favorite kid.

Roll down the block with this little black **Robot Rabbit** (on a bright orange t-shirt) on your back and you can intimidate every carrot, radish or cuke in your way.

CIRCLE 350 ON READER SERVICE CARD

Another Hallmark in Programming

Wes W. Henley Jr.

```
LIST

40  HOME
50  REM ...LUCK-PRINT (ADPD FM CREAT.COMP.APR 80.V6#4.P18.APR-FOOL-SIDE) BY W.HENLEY
60  PR1HT "YOUR MESSAGE, PLEASE (IN 60 LETTERS OR"
65  IHPUT "LESS): ";A$:L =  LEH (A$)
70  D1M T$(120): FOR I = 1 TO 5: PRIHT : NEXT I
100  FOR J = 0 TO  1NT (60 / L)
110  FOR I = 1 TO L
120 T$(J * L + I) =  MID$ (A$,1,1)
130  NEXT I: NEXT J
140 C = 0
150  PR# 1
200 A1 = 1:P = 1:C = C + 1: 1F C = 37 TNEN 999
205  PR1NT
210  READ A:A1 = A1 + A: IF P = 1 THEN 300
240  FOR I = 1 TO A: PRINT " ";: HEXT I:P = 1: GOTO 400
300  FOR I = A1 - A TO A1 - 1: HTAB 18: PR1NT T$(I);: NEXT I:P = 0
400  IF A1 > 60 THEH 200
410  GOTO 210
600  DATA  60,1,12,18,12,5,10,2,3,8,22,8,9,6,4
610  DATA  4,6,24,6,11,4,5,4,6,24,6,11,4,5
620  DATA  4,6,24,6,11,4,5,4,6,24,6,11,4,5
630  DATA  4,6,24,6,11,4,5,4,6,24,6,11,4,5
640  DATA  4,6,24,6,11,4,5,4,6,24,6,11,4,5
650  DATA  4,6,19,1,4,6,11,4,5,4,6,19,1,4,7,9,5,5
660  DATA  4,6,18,2,4,7,9,5,5,4,6,17,3,5,19,6
670  DATA  3,8,14,5,5,19,6,1,29,6,17,7,1,29,13,5,12
680  DATA  4,25,3,11,5,11,1,2,28,3,8,7,8,4
690  DATA  1,30,2,7,6,7,7,1,5,22,3,2,7,3,7,10
700  DATA  1,5,23,2,2,7,1,7,12,1,5,24,1,2,12,15
710  DATA  1,5,27,12,15,1,5,27,14,13
720  DATA  1,5,27,7,1,8,11,1,5,27,7,3,7,10
730  DATA  1,5,27,7,5,7,8,1,5,24,1,2,7,7,7,6
740  DATA  1,5,23,2,2,7,9,7,4,1,30,2,7,10,7,3
750  DATA  2,28,3,7,10,7,3,3,26,3,9,7,10,2
760  DATA  4,24,2,14,2,13,1,60
770  DATA  5000
999  FOR I = 1 TO 5: PR1NT : NEXT I: PR# 0: EHD
```

First there was LOVE, then came LUST. Now, in a third (and final) version of greeting-card graphics, we get a bit of LUCK. □

Wes W. Henley Jr., 2144 Concord Dr., Billings, MT 59102.

```
CONGRATULATIONSFRIENDANDBESTW1SNESONYOURNINETEEH81GRADUATION
C            HSFRIENDANDBESTW1S            ETEEN          ON
CON        IONSFRIENDAHDBESTWISHE        INETEEN81      TION
CONG      T1OHSFRIENDANDBESTW1SNES      H1NETEEH81G    AT1ON
CONG      T1OHSFRIENDANDBESTW1SNES      N1NETEEN81G    ATION
CONG      T1ONSFRIENDANDBESTW1SNES      N1NETEEN81G    ATION
CONG      TIONSFR1EHDAHDBESTWISHES      HINETEEN81G    AT1ON
CONG      TIOHSFR1EHDAHDBESTW1SNES      N1NETEEH81G    AT1OH
CONG      TIONSFR1ENDANDBESTW1SNES      N1NETEEN81G    ATION
CONG      TIONSFR1EHDAND8ESTW1SNES      N1NETEEN81G    AT1ON
CONG      T1ONSFR1ENDAND8ESTW1SNES      NINETEEN81G    AT1ON
CONG      T1ONSFR1ENDAND8ESTW SHES      N1NETEEN81G    AT1ON
CONG      T1ONSFR1ENDAND8ESTW SNES       1NETEEN81     AT1OH
COHG      TIONSFR1ENDAND8EST  SNES       1NETEEH81     ATION
CONG      TIONSFR1ENDAND8ES   SNESO                   UATION
COH        IONSFRIENDAND8     SNESO                   UATION
C                             SHESON                 DUAT1ON
C                             SHESONYOURN1N     81GRADUAT1ON
CONG                         ISH           ETEEH           H
CO                            SHE        INETEEN        T1ON
C                              NE       NINETE       DUATION
C     TULATIONSFRIENDANDBEST   HE       N1N       GRADUAT1OH
C     TULATIONSFRIENDAND8ESTW  NE       N       81GRADUAT1ON
C     TULATIONSFRIENDANDBESTWI HE            EEN81GRADUAT1ON
C     TULATIONSFR1ENDANDBESTW1SNE            EEN81GRADUAT1ON
C     TULATIONSFR1ENDANDBESTW1SNE              N81GRADUAT1ON
C     TULAT1ONSFR1ENDAND8ESTW1SNE       N        1GRADUAT1OH
C     TULAT1ONSFR1ENDANDBESTW1SHE       N1N       GRADUATIUN
C     TULAT1ONSFR1ENDAND8ESTW1SHE       N1NET       ADUAT1ON
C     TULAT1ONSFR1ENDANDBESTW1 NE       N1NETEE       UAT1ON
C     TULAT1ONSFR1ENDANDBESTW  NE       N1NETEEN8       T1ON
C                              NE       N1NETEEN81       1ON
CO                            SNE       N1NETEEN81       ION
CON                          ISH         INETEEH          OH
CONG                        WI              TE             N
CONGRATULATIONSFR1ENDAND8ESTWISNESONYOURN1NETEEN81GRADUAT1ON
```

MORE MAKERS BET ON MINI-WINCHESTERS

David H. Ahl

Two more makers have entered the mini-Winchesster drive fray. Rotating Memory Systems (RMS), a new Sunnyvale firm announced three 5-1/4" drives with one, two and four platters. Each drive stores 3.18 Mbytes unformatted. For the most part the drives seem similar to Shugart's entries and, indeed, can use a Shugart interface and controller.

International Memories, Inc. of Cupertino announced a drive with 6.91 Mbyte capacity presumably using two platters.

Prices are in the $450 range (OEM) for two platter drives which means after adding a housing, interface electronics, and markup, consumers will wind up paying $3000 plus for about 6 Mbytes of storage. That's one third to one half the price of comparable storage on floppy disks.

IS THE BUBBLE BURSTING?

While plug-in bubble memory looked like it held more promise than Winchester drives, some of the bubbles are bursting. Rockwell, one of the earliest entrants in the bubble-memory market, announced it has dropped its program. Rockwell had introduced a 256K bubble with Motorola as second source, but this, along with the 1 M-bit project, has been dropped.

Keeping bubbles afloat, Motorola is continuing with its own 1 M-bit development and a product announcement is promised for later this year. TI, also, is continuing to move ahead on bubble memory development.

HOW ABOUT A GIGABYTE OF MEMORY?

Winchester disks or bubble memories not your cup of tea? How about an optical laser video disk? On these same pages back in March 1976 (!) we said video disks would be the mass storage device of the future. Well, Xerox will announce a read/write video disk "soon." The working area is acccessed in 10 byte sectors (good grief!) and the entire disk has 10 gigabytes (10^{10} bits more or less) available. Price is said to be under $2500. On a price per bit basis, that's about 1/100th the cost of the cheapest storage available today. Availability in 1982--maybe.

DYNABOOK/SMALLTALK STILL UNDER WRAPS?

More immediately, Xerox will announce a highend personal/professional system in June for around $20K. Sounds like a beefed up HP-85 or IBM 5120 although we're hoping for something more like the Dynabook/Smalltalk system from Xerox PARC (see Oct. and Nov. 1980 issues). We'll see at NCC.

POWERFUL 32-BIT MICROCOMPUTER

At the February Int'l Solid State Circuits Conf., Intel introduced a "micromainframe, " the iAPX 432. This designed-from-scratch, very-large-scale integration (VLSI) system packs the power of a mid-range IBM 370 on just three chips.

The 432 is designed to support very-high-level programming languages such as Ada, a "superset" of Pascal; hardware operating system; and large memory addressing.

Evaluation kits of the 432 sell for $3900 but this price should drop to the hundreds range as production volumes are reached.

CAESAR'S WATCH

Paul Raymer

The discovery recently at the Gelati digs—where an ancient pizzaria was uncovered by horologists at the University of Nevada in cooperation with the State Historical Society and Wine Tasting Association of Manjare, Italy—is the source of the reference material on this wonderful program.

Evidence gathered by examining bits of chard and thyme and verifying that material with the carbon-zinc dating equipment by Ray-O-Vac proves within a shadow of a doubt that the materials were those of either Julius or Augustus Caesar or some other famous Roman.

While some artistic license was taken to translate the ancient documents—many of them written in a foreign language which made them hard to understand—the recreation of what the author honestly believes is either the pocket watch of Julius Caesar, or the floor plan of a barbaric hovel in Rome, has been attempted. Encouraged by his research, the author proceeded on the basis that it was indeed a pocket watch, and comparisons between the resultant diagrams and Roman water clocks show a faint resemblance.

Unfortunately, because of limited financial resources and the refusal of the Rand Corporation to provide a grant, the author was unable to get final copyright releases from the Caesar family and hopes the heirs (in Las Vegas, Lake Tahoe and Atlantic City) will understand and provide their tacit approval by not taking any legal action. Because all of the original documents were carefully studied, the author believes the resultant program is as authentic and accurate as any of his other programs.

In accordance with tradition, the program has been translated to run on an Apple Computer to take full advantage of the low resolution graphics of that computer. Although it is surprisingly accurate for a water clock, provisions have been made for moderate time adjustments. This was, of course, not included in the original plans by Mr. Caesar since it wasn't really critical whether a battle started at 6:00 or 6:10. Of even less import was whether the lions were admitted to the arena at 8:00 or 8:15—certainly of interest neither to the Christians nor the lions.

The clock, of course, is based on a 12-hour cycle and resets itself automatically. This, according to historical data, is because of the marvelous system of viaducts originated by the Romans so long ago, in the olden days.

Because the plans upon which this clock are built were prior to Pope Gregory's fooling around with the calendar, the alert computerist will note a gap of 11 days. However, with inflation and the state of the economy, it may not be that bad after all.

How the Program Works

Lines 100-250 are the introduction to the program—a reversed image title. This is a lazy way of having the info ordinarily used as REM statements become your title.

Lines 260-300 clear the screen and read data which will later be used to translate arabic numbers to Roman numerals. Values are established for variables LL, T and TT to be defined later.

Lines 300-420, in effect, explain how the time adjustment variables may be changed, if necessary. Please note that only the first two letters of the variables are actually used. Full use of Roman names is because of the author's involvement in Latin as a student many (many, many) years ago.

Paul Raymer, P.O. Box 42831, Las Vegas, NV 89104.

CALIFORNIA

Advance Data Concepts—2280 Diamond Blvd., Concord, 94520; (415) 671-9016. 9-5 Mon-Fri. Vector-Graphic, CP/M Software Headquarters-User's Group.

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Watch, continued...

Lines 430-460 accept your input to start clock on time, and begin graphics mode.

Lines 470-590 start graphics to build water spigot and containers to receive water drops.

Lines 600-630 start clock to match input of hours. This input will be corrected at the "minute" routine and then again when the "hour" change takes place. This enables you to correlate the program with real time.

Lines 640-1080 start "water dripping" routine which will fill up the "seconds" vessel. When 60 drops have fallen, the cycle will shift to emptying the vessel.

Lines 1990-2430 empty the "seconds" vessel and start to fill the "minutes" container. The contents are emptied from the bottom of the "seconds" container to fill the "minutes." Ports which are opened during the transfer of water are then closed upon completion of this exchange. The time is printed, after having been converted from Arabic to Roman with the use of the R$(H) and R$(M). Both use the same data since the figures are actually the same, for this reason the Dim was set originally at R$(60) to provide for this contingency.

Lines 3000-3070 start the "hour-making" subroutine. These lines remove all image from the "minutes" vessel.

Lines 3080-3120 provide the graphics to begin the "hour" bottle.

Lines 3130-3310 add one hour to the hour bottle for each hour indicated in program. Gingerbread allows for a bar to cross over the screen to apparently "fill" the bottle. A time delay is established at this point to enable the action to be seen.

Lines 3320-4120 adjust the hour. When time exceeds 12 (limit of the program) all variables are returned to zero to start new cycle. This enables the program to run continuously, with a fair degree of accuracy.

5000-5050 are the data statements which are used to translate the Arabic (decimal, we call them) to Roman numerals . . . the easy way. □

```
100  TEXT : HOME : CLEAR
110  INVERSE
120  PRINT "                          "
130  PRINT " ********************** "
140  PRINT " *                    * "
150  PRINT " *   CAESAR'S WATCH   * "
160  PRINT " *                    * "
170  PRINT " *   THE BARGAIN BOX  * "
180  PRINT " *     PO BOX 42831   * "
190  PRINT " *  LAS VEGAS NEVADA  * "
200  PRINT " *        89104       * "
210  PRINT " *                    * "
220  PRINT " ********************** "
230  PRINT "                          "
240  REM
250  FOR W = 1 TO 3000: NEXT W: NORMAL
260  HOME
270  DIM R$(60)
280  FOR X = 1 TO 60: READ R$(X): NEXT X
290 LL = 5:T =  - 1:TT =  - 1
300  REM
310  REM  TIME ADJUST
320  REM  JULIUS=SECOND EMPTY
330  REM  AUGUSTUS=FILLING
340  REM  OCTAVIUS=HOUR ADJUST
350  REM
360 JULIUS = 9:AUGUSTUS = 10:OCTAVIUS = 100
370  REM
380  REM  ROMAN WATER CLOCK
390  REM  ORIGINAL CONCEPT BY
400  REM  PAUL RAYMER
410  REM  VIII/IX/MCMLXXX
420  REM
430  INPUT "HOW MANY MINUTES PAST THE HOUR? ";M
440  INPUT "WHAT IS THE HOUR? ";H
450  HOME
460  GR
470  COLOR= 15
480  FOR X = 0 TO 39: HLIN 0,4 AT X: NEXT X
490  HLIN 0,8 AT 38: HLIN 0,8 AT 39
500  VLIN 18,39 AT 8
510  FOR X = 10 TO 15: HLIN 5,17 AT X: NEXT X
520  FOR X = 16 TO 21: HLIN 13,17 AT X: NEXT X
530  COLOR= 1
540  HLIN 12,13 AT 35: HLIN 12,13 AT 34
550  HLIN 30,32 AT 35: HLIN 30,32 AT 34
560  VLIN 34,39 AT 14: VLIN 34,39 AT 30
570  HLIN 14,30 AT 38: HLIN 14,30 AT 39
580  COLOR= 7
590  REM
600  REM  START CLOCK
610  REM
620  GOSUB 3000
630  GOSUB 2390
640 R = 37:D = 22
650  PLOT 15,D
660  FOR W = 1 TO AUGUSTUS: NEXT W
670 D = D + 1: IF D = R + 1 THEN  GOSUB 1000
680  IF R = 33 THEN  GOSUB 2000
690  COLOR= 0
700  PLOT 15,D - 1
710  COLOR= 7
720  GOTO 650
1000  REM
1010  REM  SECOND MAKER
1020  REM
1030 P = P + 1
1040  PLOT 14 + P,R
1050  IF P = 15 THEN R = R - 1:P = 0
1060  COLOR= 7
1070 D = 22
1080  RETURN
1990  REM
2000  REM  MINUTE MAKER
2010  COLOR= 15
2020  FOR X = 8 TO 13: PLOT X,39: NEXT X
2030  COLOR= 0
2040 R = R + 1
2050 PP = 15
2060  FOR X = 1 TO 60
2070 PP = PP - 1
2080  PLOT 15 + PP,R
2090  IF PP = 0 THEN R = R + 1:PP = 15
2100  COLOR= 7
2110  PLOT 14,37: FOR W = 1 TO JULIUS: NEXT W
2120  COLOR= 0: PLOT 14,37
2130  COLOR= 7
2140  PLOT 13,37: FOR W = 1 TO JULIUS: NEXT W
2150  COLOR= 0: PLOT 13,37
2160  COLOR= 7
2170  PLOT 13,38: FOR W = 1 TO JULIUS: NEXT W
2180  COLOR= 0: PLOT 13,38
2190  COLOR= 7
2200  FOR V = 11 TO 5 STEP  - 1
2210  COLOR= 7: PLOT V,38
2220  FOR W = 1 TO JULIUS: NEXT W
2230  COLOR= 0: PLOT V,38
```

```
2240  NEXT V
2250  NEXT X
2260 T = T + 1
2270  COLOR= 7: PLOT LL,37 - L:LL = LL + 1
2280  IF LL = 8 THEN LL = 5:L = L + 1
2290  IF L = 21 THEN LL = 5:L = 0
2300  IF M > T THEN 2260
2310 R = R - 1
2320  COLOR= 1: PLOT 14,37
2330  COLOR= 15: PLOT 8,38
2340  HLIN 0,8 AT 38
2350  COLOR= 0
2360  FOR X = 9 TO 13: PLOT X,39: NEXT X
2370 M = M + 1: IF M = 60 THEN H = H + 1:M = 0: GOSUB 300
2380  IF H = 13 THEN  GOSUB 4000: GOSUB 3000
2390  HOME : PRINT  TAB( 2)"MINUTES"; TAB( 20)"SECONDS";
      TAB( 35)"HOURS"
2400  PRINT
2410  PRINT  TAB( 13)"TEMPUS EST ";R$(H); CHR$ (32);R$(M)
2420  COLOR= 3
2430  RETURN
3000  REM
3010  REM  HOUR MAKER
3020  REM
3030  COLOR= 0
3040  FOR X = 17 TO 38
3050  HLIN 5,7 AT X
3060  FOR W = 1 TO AUGUSTUS: NEXT W
3070  NEXT X
3080  COLOR= 15
3090  VLIN 14,39 AT 36: VLIN 14,39 AT 39
3100  HLIN 36,39 AT 14
3110  PLOT 34,28
3120  HLIN 34,35 AT 29
3130  REM
3140  REM  ADD AN HOUR
3150  REM
3160  COLOR= 0
3170  VLIN 18,27 AT 6
3180  COLOR= 15
3190  HLIN 8,33 AT 27
3200  FOR W = 1 TO 50: NEXT W
3210 TT = TT + 1
3220  IF TT = 13 THEN 3360
3230  COLOR= TT + 1
3240  PLOT 37,39 - (2 * TT)
3250  PLOT 38,39 - (2 * TT)
3260  COLOR= 15
3270  HLIN 36,39 AT 39
3280  COLOR= 0: HLIN 6,34 AT 27
3290  COLOR= 15: VLIN 18,28 AT 8
3300  IF H > TT THEN 3140
3310 T = T - 1
3320  REM
3330  REM  ADJUST HOUR
3340  FOR W = 1 TO OCTAVIUS: NEXT W
3350  REM
3355 LL = 5:L = 0
3360  RETURN
4000  REM
4010  REM  CLEAR TO ONE AFTER 12
4020  REM
4030  COLOR= 0
4040  FOR X = 15 TO 38
4050  HLIN 37,38 AT X
4060  FOR W = 1 TO AUGUSTUS: NEXT W
4070  NEXT X
4080 TT = 0
4090 H = 1
4100 R = 37
4110 LL = 5:L = 0
4120  RETURN
5000  REM
5010  REM  ARABIC TO ROMAN
5020  REM
5030  DATA  I,II,III,IV,V,VI,VII,VIII,IX,X,XI,XII,XIII
      XIV,XV,XVI,XVII,XVIII,XIX,XX
5040  DATA  XXI,XXII,XXIII,XXIV,XXV,XXVI,XXVII,XXVIII,
      XXIX,XXX,XXXI,XXXII, XXXIII,XXXIV,XXXV,XXXVI,
      XXXVII,XXXVIII,XXXIX,XL
5050  DATA  XLI,XLII,XLIII,XLIV,XLV,XLVI,XLVII,XLVIII,
      XLIX,L,LI,LII,LIII,LIV,LV,LVI,LVII,LVIII,LIX,LX
5060 FINIS
```

...new products...new

COMPUTERS

Z-80 BUSINESS COMPUTER

IBC/Integrated Business Computers has introduced the Ensign computer.

Features of the Z-80 based Ensign include 64K to 768K byte memory. 14. 42. 70. and 150MB winchester disk drives. 17MB tape cartridge and 9 track reel-to-reel tape drive. slave twin Z-80s to handle all serial I/O with 2K byte buffer/serial I/O port (32K byte total). and a

third slave Z-80 to handle all disk/tape I/O and an advanced DMA controller that allows data transfer to any memory whether selected by main CPU or not.

Software supported by the IBC Ensign includes MP/M. CP/M. Oasis. and MVT-FAMOS. Prices range from $7.000 to $33.000.

IBC/Integrated Business Computers. 22010 S. Wilmington Ave.. Carson. CA 90745.

CIRCLE 307 ON READER SERVICE CARD

SMALL BUSINESS COMPUTER

The iBEX Small Business Computer will handle word processing. general accounting and data processing for manufacturers. distributors. doctors. dentists. accountants. and retail or service organizations.

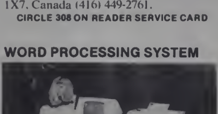
An entry level iBEX Model 2100 computer contains 64K of RAM. one 5 1/4" floppy disk with 80KB of disk storage. typewriter/numeric keyboard and a 9" display screen with 24 lines of 80 characters per line readout in upper/lower case. High speed printers or a slower letter-quality printer can be interfaced with any iBEX model. and all iBEX models can be expanded by increasing the size of the memory and disk storage.

The iBEX Model 2100 retails for $4.878 and the top of the line Model 7101 retails for $8.550.

Norango Computer Systems. Inc.. 801 York Mills Rd.. Don Mills. Ontario M3B 1X7. Canada (416) 449-2761.

CIRCLE 308 ON READER SERVICE CARD

WORD PROCESSING SYSTEM



A fully integrated word processing and mail list system starting under $9.000 has been announced by ADL Enterprises.

Dubbed ADLex Executive Word Processing the turnkey system is based on the Altos ACS-8000 microcomputer. offering the customer the choice of floppy or hard disk storage up to 59 million characters.

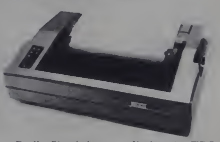
A minimum ADLex configuration consists of the Altos CPU. a Televideo or comparable CRT. a Xerox 1700 Series Printer. and the ADLex Word processing program package.

ADL Enterprises. Richard Mine Rd.. Wharton. NJ 07855. (201) 328-1300

CIRCLE 309 ON READER SERVICE CARD

TERMINALS & I/O

TRS-80 LINE PRINTER V

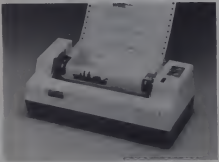


Radio Shack is now offering the TRS-80 Line Printer V. said to be especially suited to heavy business use.

The printer has a bidirectional. logic-seeking dot-matrix head that prints high-quality 7x9 upper and lower case characters (with descenders) 132 columns wide. It features software selectable 5. 7.5. 10 or 15 character per inch. 26 European characters and 30 graphics patterns. Print speed is given as 160 characters per second. 60 lines per minute. $1860.

The Line Printer V is available exclusively from participating Radio Shack stores and dealers. and Radio Shack Computer Centers.

IMPACT PRINTER WITH SINGLE PRINT HAMMER



A new impact printer which uses a single print hammer is now available from the Axiom Corp.

The GP-80M prints both graphics and alphanumerics, and employs a rotating platen with protruding splines positioned behind the paper. The character or graphics image is created by multiple hammer strikes in rapid succession as the print head advances across the paper in front of the rotating platen.

Standard features of the GP-80M include ASCII upper and lower case character sets, up to 80 columns with 12 characters per inch, adjustable tractor feed, three copy reproduction, 12-watt power consumption, and Centronics parallel interface. Optional interfaces include RS-232C, serial TTL, 20mA current loop, IEEE 488, plus interfaces for most popular small computers, including Apple, TRS-80, PET, HP85 and Sharp.

In addition, the standard GP-80M has full graphics capability with a resolution of better than 60 dots per inch on both horizontal and vertical axes. Dot graphics, normal characters and double width characters can be intermixed on a single line under software control. $399.

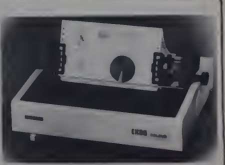
Axiom Corporation, 1014 Griswold Ave., San Fernando, CA 91340. (213) 365-9521.

CIRCLE 311 ON READER SERVICE CARD

COLOR MATRIX PRINTER

A new color matrix printer from Britain, the Integrex CX 80, is said to be a highly cost-effective solution for color printout. The machine can print text, graphs, histograms and color VDU dumps in seven different colors, with no restriction on mixing characters, dot-addressed areas and color changes on the same line.

Colors are selected by one of seven color control codes. Strips from the tri-



color ribbon are selected to produce the required colors, which simplifies the host program requirements.

The printer is compatible with most processors. The standard interface is Centronics; RS232/V24 and IEEE 488 are optional.

Integrex Inc., 233 North Juniper St., Philadelphia, PA 19107. (215) 627-0966.

CIRCLE 312 ON READER SERVICE CARD

DESKTOP TELEPRINTERS

A new line of desktop teleprinters—designed to move message communications out of the TWX/Telex room and onto an executive desk—is available from Trendcom. Using existing telephone lines, a teleprinter can communicate with TWX and Telex world-wide, as well as direct-dial terminals and computer systems.

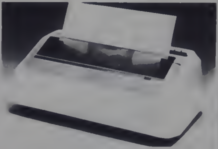
The teleprinters are offered in two models, with 40 and 80 characters per line respectively. Messages can be transmitted as they are typed, or they can be prepared off-line and transmitted with one push of a button.

Single unit prices are $595 and $695 for the receive-only Trendcom 400 and 800 Teleprinters. Plugging in a Trendcom 600 Intelligent Keyboard ($295) converts either teleprinter into an automatic send/receive (ASR) communications terminal.

Trendcom, 480 Oakmead Pkwy., Sunnyvale, CA 94086. (408) 737-0747

CIRCLE 313 ON READER SERVICE CARD

CORRESPONDENCE-QUALITY PRINTER



A full-width 132-column printer which can produce correspondence-quality overlapping dot-matrix characters at high speed has been introduced by Integral Data Systems, Inc.

The Model 560 is intended for data and text processing applications and prints bidirectionally at speeds up to 150 characters per second.

In addition to standard features, including proportional character spacing, automatic text justification, variable character sizes and advanced forms control functions, the Model 560 offers a raster graphics printing option. $1695.

Integral Data Systems, Milford, NH 03055. (603) 673-9100

CIRCLE 314 ON READER SERVICE CARD

PERIPHERALS

EXTENDS TRS-80 COLOR COMPUTER BUS

Percom Data Company has introduced the Color Connection, a device which permits extending the TRS-80 Color Computer system bus as a System-50 bus (SS-50 bus).

Three expansion possibilities include: adding a mini-disk storage system, adding a word-processing quality video display system and expanding the Color Computer memory beyond the internal 16K limit. $99.95.

Percom Data Company, 211 N. Kirby, Garland, TX 75042. (214) 272-3421 or (800) 527-1592.

CIRCLE 315 ON READER SERVICE CARD

COMPUTER-VIDEO DISK INTERFACE

SSM Microcomputer Products has unveiled an intelligent interface unit that allows read-only video disks to be controlled from a computer keyboard. The interface unit is 6802-based.

SSM's UEI (Universal Extended Interface) will be available in two versions for either serial RS-232 use or IEEE 488 bus-based systems. A typical implementation would include, besides the UEI, a microcomputer with keyboard and video terminal, the DiscoVision player, and a TV monitor.

SSM Microcomputer Products, 2190 Paragon Dr., San Jose, CA 95131. (408) 946-7400

CIRCLE 316 ON READER SERVICE CARD

GRAPHIC TABLET FOR PET

Kurta Corporation has announced that its Kurta Graphic Tablet is now directly compatible with PET computers. A special feature of the Kurta Graphic Tablet is that hard copy verification is simplified because a standard 8 1/2" x 11" pad of paper fits exactly onto the surface of the tablet.

Resolution is 100/200 points per inch and the conversion rate is 100 coordinate pairs per second.

Kurta Corporation, 206 S. River Dr., Tempe, AZ 85281. (602)968-8709.

CIRCLE 317 ON READER SERVICE CARD

TRS-80 DEVELOPMENT SYSTEM

The Developmate 81 adds both Z-80 in-circuit-emulation and EPROM/EEPROM programming capability to the TRS-80.

The Developmate comes complete with EPROM and EEPROM programming software, power supply, emulation cable, TRS-80 cable, and a "universal" personality module. It will work with any size Model I TRS-80, with or without expansion interface. $329.

Orion Instruments, 172 Otis Ave., Woodside, CA. (415)851-1172.

CIRCLE 318 ON READER SERVICE CARD

DIGITAL SPEECH PROCESSOR

The Mimic Speech Processor converts speech signals to a digital bit stream for computer storage or Automatic Speech Recognition purposes. It also reconstructs the digital speech representation to analog form for reproduction through an available speaker.

Since both the speech encoder (input) and decoder (output) functions are located in a single unit, the system can also be used for speech communications applications without a computer. Prices range from $79 to $169.

Mimic Electronics Co., P.O. Box 921, Acton, MA 01720.

CIRCLE 319 ON READER SERVICE CARD

CIRCLE 227 ON READER SERVICE CARD

DISK CONTROLLER FOR APPLE

Lobo Drives International, announces the Lobo LCA-22, a disk controller board for the Apple. The LCA-22 is software compatible with Apple DOS and contains 256 bytes of onboard Boot ROM. It will control up to four 8" single- or double-sided, single- or double-density disk drives with a total storage capacity of 4.4 Megabytes. $699.

Lobo Drives International., 354 South Fairview Ave., Goleta, CA 93117. (805) 863-1576.

CIRCLE 320 ON READER SERVICE CARD

MAGAZINES, NEWSLETTERS

INFORMATION MANAGEMENT INFORMATION

Business people, industrial and institutional executives and professionals interested in learning about the new science of information management may find, "An Introduction to Information Management," a useful brochure.

Single copies of the brochure are available without charge upon request, on letterhead, to Clapp & Poliak, Inc., 245 Park Ave., New York, NY 10167.

PERIODICAL INDEX

The *Microcomputer Index* indexes 18 microcomputer publications. Issued quarterly, it covers three months of published material in each edition.

Articles are indexed in an alphabetical subject list, and abstracts are provided for all articles in each issue of each magazine or newsletter.

Microcomputer Information Services, 3070 Adams Way, Santa Clara, CA 95051.

CIRCLE 322 ON READER SERVICE CARD

ELECTRONICS NEWSLETTER

Educational Electronics is a monthly newsletter which covers all aspects of electronics as it pertains to education.

The subscription price for 12 issues is $25 until September 1 and $30 thereafter.

Educational Electronics, One Lincoln Plaza, New York, NY 10023.

TRS-80 SOFTWARE REVIEWS

The *Software Critic* is a bi-monthly publication devoted to reviewing computer programs written for TRS-80 Models I and III. It carries no advertising, sells no software, and has no affiliation with any commercial software interest.

Types of software reviewed include: utilities; operating system; word and text processors; statistical systems; payroll; A/R, A/P, and G/L systems; languages; mailing lists; graphics; market analysis; mathematical applications; education; engineering; terminal programs; inventory; data base systems; real estate; income tax; security; and games.

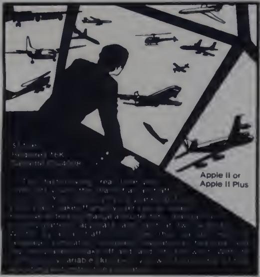
The *Software Critic* costs $15 per year and is available from the Software Critic, Box 3CH, University Park, NM 88003.

Apple II

sensational software

creative computing software

Air Traffic Controller



Action Games

Cassette CS-4017 $11 95 3 Games

Cycle Jump Try to jump over rows of cars, buses and trucks

Mine Rover Use your rover to cross a mine field with moving mines

Road Machine Drive over a curving mountain road as fast as possible Eight skill levels

Milestones

Cassette CS-4015 $11 95 Requires 48K Applesoft or Apple II Plus

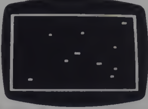
The object of Milestones is to complete a 700-mile auto trip before your opponent the computer You must deal with hazards of the roads stop lights flat tires speed limits accidents and gas shortages Spectacular high-resolution color graphics

Bumping Games

Cassette CS-4020 $11 95 3 Programs

Obstacle Course. This multi-level course includes hurdles, ladders tires and penalty areas Different every time

Hustle. The score keeps building but the escape routes dwindle Can you reach the blocks before they disappear?



Bumper Blocks. An absorbing game of evasion and collision Five skill levels

Action & Bumping Games

Disk CS-4518 $24 95
Requires 32K Applesoft or Apple II Plus
This disk contains all six games from cassettes CS-4017 and CS-4020

Milestones

Disk CS-4515 $19 95
Requires 48K Apple II or Apple II Plus
In addition to the game itself this disk contains the complete playing instructions

Advanced Air Traffic Controller

Disk CS-4517 $19 95
Requires 16K Apple or Apple II Plus

This price is an advanced version of Air Traffic Controller (Cassette CS-4008) offering additional features and challenge

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CIRCLE 300 ON READER SERVICE CARD

BOOKS AND BOOKLETS

BUSINESS SOFTWARE SELECTION KIT

Intended as a reference resource for small businesses, Inotec's Business Software Selection Kit assists in the search for professional business applications packages.

The BSSK contains several pages of data on each package, including such information as functional summaries, sample printouts, input requirements, output formats, minimum system requirements, and cost. $39.95.

Inotec, Inc., P.O. Box 1587, Mail Stop 106, Clemson, SC 29631.

CIRCLE 325 ON READER SERVICE CARD

SYSTEMS SOFTWARE

LANGUAGES

The Micro Works offers a software package for exploring the potential of the TRS-80 Color Computer at the assembly language level. **CBug Monitor** Tape has 19 commands and is relocatable and reentrant. $29.95. CBug Monitor ROM is the same program supplied in ROM $39.95. Also available is a **disassembler** for the Color Computer. $49.95. The Micro Works, P.O. Box 1110 Del Mar, CA 92014. (714)942-2400.

CIRCLE 326 ON READER SERVICE CARD

DATABS, a data abstraction language, runs under CP/M and is suitable for control and systems programming. The built-in types of DATABS are Boolean, character, single-byte integer, double-byte integer and string. $49.50. Softronics, 36 Homstead Lane, Roosevelt, NJ 08555.

CIRCLE 327 ON READER SERVICE CARD

Focal-65, DEC's high-level language adapted for the 6502 is available on 5 1/4" disk for OSI systems. $49.50. The 6502 Program Exchange, 2920 West Moana, Reno, NV 89509.

CIRCLE 328 ON READER SERVICE CARD

The **Reformatter** disk conversion software allows CP/M users to exchange data files with DEC computers. It runs under CP/M and reads and writes floppy disks in the DEC RT-11 format. $195. MicroTech Exports, 467 Hamilton Ave., Palo Alto, CA 94301. (415)324-9114.

CIRCLE 329 ON READER SERVICE CARD

KBE is a keyboard editor which incorporates full-screen editing with programmable keys that can be stored on disk. It includes a driver that eliminates keyboard bounce and provides lower case. KBE requires a 32K disk system. $39.95. The Alternate Source, 1806 Ada St., Lansing, MI 48910. (517)487-3358.

CIRCLE 330 ON READER SERVICE CARD

North Star CP/M 2.2 provides Horizon users with a fully compatible version of CP/M for both floppy and hard disk systems. $230. North Star Computers, Inc., 1440 Fourth St., Berkeley, CA 94710. (415)527-6950.

CIRCLE 331 ON READER SERVICE CARD

Friends Software announces **Access/80**, a report generation and file maintenance system and language designed to run on Z-80 and 8080 microprocessors under CP/M. $795. Friends Software, Tioga Bldg., Suite 440, 2020 Milvia St., P.O. Box 527, Berkeley, CA 94701.

CIRCLE 332 ON READER SERVICE CARD

Database System from Tarbell Electronics runs under CP/M. It features variable length fields with field names that may be of any length and may include spaces, and requires CBasic. $50. Tarbell Electronics, 950 Dovlen Pl., Suite B, Carson, CA 90746. (213)538-4251.

CIRCLE 333 ON READER SERVICE CARD

APPLICATIONS SOFTWARE

GAMES & RECREATIONAL

Gin Rummy 3.0 is now available for Atari 800 computers with 32K of memory. It includes color graphics and sound. $19.95. **Casino Blackjack/Counter** for TRS-80 Models I and II enables the player to practice card counting as well as play the game. Cassette. $14.95; disk $19.95. Manhattan Software. P.O. Box 35. Pacific Palisades. CA 90272. (213)454-8290.

CIRCLE 334 ON READER SERVICE CARD

Tuesday Morning Quarterback puts the player in the roles of quarterback. coach and fan in a real-time action game against his Apple. It is available on disk for the 48K Apple with Applesoft in ROM. $29.95. Automated Simulations. P.O. Box 4247. Mountain View. CA 94040.

CIRCLE 335 ON READER SERVICE CARD

Strategic Simulations has introduced three games for 48K Apples with Applesoft in ROM and one disk drive. **Cartels & Cutthroats** simulates the operation of a group of manufacturing firms in the U.S. economy. Up to six people can play. $39.95. **Torpedo Fire** simulates anti-submarine warfare during World War II and **Operation Apocalypse** is a World War II ground simulation. Both games can be played with two players or solitaire. Each is $59.95. Strategic Simulations Inc.. 465 Fairchild Dr.. Suite 108. Mountain View. CA 94043. (415) 964-1353.

CIRCLE 336 ON READER SERVICE CARD

Personal Software has added **Zork**, the Great Underground Empire. to its strategy game series. Zork has a working vocabulary of over 600 words. It is available on 5 1/4" disk for Apple and TRS-80 computers with 32K of memory. $39.95. Also available are **MicroChess** and **Checker King** for the Atari 400 and 800. MicroChess features eight levels of play. and Checker King allows single. double and triple jumps. forces jumps and plays according to the tournament rules of

DISCOUNT

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DRS or QRS or RTL	$269/$35
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WordStar	$324/$60
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DataStar	$249/$60
WordMaster	$119/$40
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Cobol-80	$574/$30
✓ M-Sort	$125/$20
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MuLisp-80	$174/$20
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General Ledger	$ 59/$20
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Payroll w/Cost	$ 59/$20
All 3	$129/$57
All 3 + CBASIC-2	$199/$71
PEACHTREE·	
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Acct Payable	$399/$40
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CIRCLE 131 ON READER SERVICE CARD

SORCERER USERS

Have you seen the best toolkit in existence for any micro computer? Did you know it was written for the

EXIDY SORCERER?

System 3 is the ultimate program development toolkit and is guaranteed to cut your Basic programming and debugging time by AT LEAST HALF!

Once loaded, this program gives Sorcerer ROM PAC Basic more than 15 extra program development commands, some of which you would not have thought possible It you purchase this piece of software and are not 100% satisfied that it is all we say it is, we will gladly refund your money in full!

The following commands are just a sample:

EDIT xx[,yy]
This allows you to edit your program just as if you were using the Wordprocessor Pac All the same numeric keypad commands are used You may even have Basic program lines over 500 characters long!

AUTO [xx[,yy]]
While entering program lines each new line number is typed for you! All the EDIT commands are available in this mode which greatly speeds program editing

REN [a[,b[,c[,d]]]]
You may renumber all or a section of your program with one simple command

TRACE [xx[,anything]]
This command runs your program and prints each line number on the screen after it is executed You may optionally print values of numeric or string variables after each line number

HELP xx
How many times have you got a SN ERROR IN LINE xx message but could not see the error? This command prints the program line in EDIT mode and places the cursor over what System 3 thinks is the error! This command is especially useful with your new very long program lines

FIND["] anything
Find and list all program lines containing anything An optional wildcard character may be included

DEF a
You may define function keys with this sophisticated routine which even includes an input feature

VAR
List all variables and their values This is often used after a program run

LIST [xx[,]yy]
List all program lines from xx to yy

DEL [xx[,]yy]
Delete all program lines from xx to yy

CLOSE
Erase all spaces in your program excepting those within quote marks and in REM statements

OLD
Recover a lost program after NEW CLOAD or RESET

CLOAD?
Verify a program on tape without the possibility of contaminating memory in the case of a TAPE ERROR

MERGE
Merge the incomming BASIC program off tape to the end of the Basic program in memory

Other features
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Prescriptive Math Drill is a computer-managed drill and practice program covering basic arithmetic skills. The student is automatically moved to the next higher level upon satisfactory completion of 20 problems at his current level. $79.95. Also available is **Wordsearch**. a program which allows a teacher to enter a series of words with which the computer creates a wordsearch puzzle. $14.95. Both programs are for the Apple. Hartley Software. 3268 Coach Lane. #2A. Kentwood. MI 49508. (616)942-8987.

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The **Individual Study Center** is an educational course designed to enable a person to teach himself any subjects he wants to learn. There are over 50 prepared subject data files available for grades 1-9. high school and adult on disk for the 48K Apple. $54.95. TYC Software. 40 Stuyvesant Manor. Geneseo. NY 14454.

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Algebra I is designed to teach the fundamental tools and concepts of beginning algebra. Features include color hi-res graphics. upper and lower case text and flow charted "information maps" which mark the learner's progress. The program requires DOS 3.3 and 48K Applesoft. $39.95. Edu-Ware Services. Inc.. 22222 Sherman Way. Suite 102. Canoga Park. CA 91303.

CIRCLE 340 ON READER SERVICE CARD

BUSINESS

Commercial Mailer. written in Applesoft for a 48K Apple/Corvus system with 80- or 132-column printer. can handle an unlimited number of mailing lists. each with a 30.000-name capacity. It is menu-driven with alphabetical order. find entry. browse. change. add. delete. and search. $250. Stonehenge Computer Company. 89 Summit Ave.. Summit. NJ 07901. (201) 277-1020. 5

CIRCLE 341 ON READER SERVICE CARD

A **General Business Bookkeeping System** for Ohio Scientific computers includes programs for payroll. inventory. accounts payable and receivable. job costing. purchase orders and general ledger with reports. The system is Level 3. Network and multi-dimensional compatible. Data Access Managemet Service. 3320 Rivers Ave.. Charleston. SC 29405. (803)554-7005.

CIRCLE 342 ON READER SERVICE CARD

Computer Consultants introduces *TRS-POS*. which allows a 16K TRS-80 Level II to function as a point of sale terminal. Features of the program include. English operator prompting and error messages. electronic memo pad and ability to track sales commissions and inventory. Prices start at $100. Computer Consultants. 310-312 Hoyt St.. Dunkirk. NY 14048.

CIRCLE 343 ON READER SERVICE CARD

Version 5 of the TCS **Business Accounting** software for the Apple includes general ledger. accounts payable. accounts receivable and payroll. Enhancements include new W-2 forms and improved menu processing. The system requires 48K of memory. Microsoft RAMcard or language card. Microsoft Softcard. CP/M and an 80-column card or external CRT terminal. TCS Corporation. P.O. Box 47550. Atlanta. GA 30362.

CIRCLE 344 ON READER SERVICE CARD

CRIC Software Systems announces a **Cash Register Inventory Control** system for the Apple II Plus with 48K memory. Pascal language card. and disk drives.

The system allows a small retailer to handle charge accounts and up to 10,000 inventory items. $999.95. CRIC Software Systems 012. 15132 Stony Plain Rd., Edmonton, Alberta, Canada. (403)483-5999.

CIRCLE 345 ON READER SERVICE CARD

Postman is a mailing list management program designed for use with the Oasis operating system. Sequential files accessible from word processors such as Oasis Script or Magic Wand may be produced for mass individualized letter mailings, and simple numerical analyses may also be prepared. Marot Software Systems. 310 Madison Ave., Suite 408, New York, NY 10017. (212)661-8550.

CIRCLE 346 ON READER SERVICE CARD

Desktop Plan II is a professional financial planning software package for the Apple which enables users to prepare financial statements, budgets, forecasts, projections and analyses. New features include hi-res graphics plotting, the ability to receive data with VisiCalc, and a moving cursor. Applesoft Basic, one disk drive and 32K of memory are required. $199.95. Personal Software. 1330 Bordeaux Ave., Sunnyvale, CA 94086.

CIRCLE 347 ON READER SERVICE CARD

A-T Enterprises announces a software package designed for the management and control of **mini-warehouse** or **self-service storage** facilities. The package requires a Z-80, 8080 or 8085 based microcomputer and 48K of memory, dual disk drives, an 80 x 24 video terminal, and an 80-column printer. $650. A-T Enterprises. 221 N. Lois, La Habra, CA 90631. (213)947-2762.

CIRCLE 348 ON READER SERVICE CARD

WORD PROCESSING

Hexspell is a spelling checker which is compatible with most word processing systems available for the TRS-80. The program reads through documents, checking words against its 29,000-word list while displaying the text for manual proofreading. A 48K TRS-80 Model I with two disk drives is required. $69. Hexagon Systems. P.O. Box 397 Stn. A, Vancouver, BC, Canada V6C 2N2. (604)682-7646.

CIRCLE 349 ON READER SERVICE CARD

The **Docuwriter Text Processor** for Apple computers features its own document writer, universal editor, custom printing element, mailing list, automatic text linker, draft writer and form letter element. $149.95. Charles Mann & Associates, Micro Software Division. 7594 San Remo Trail, Yucca Valley, CA 92284. (714)365-9718.

CIRCLE 351 ON READER SERVICE CARD

Muse announces the **Form Letter Module** for use with the Super-Text Word Processor and Address Book Mailing List in printing personalized form letters. The program requires an Apple computer with 48K and disk drive. $100. Muse Software. 330 North Charles St.. Baltimore. MD 21201.

CIRCLE 352 ON READER SERVICE CARD

Write-On! II allows the user to create and maintain data files. such as mailing lists. and then merge them into textfiles. such as letters or mailing labels. The program is designed for the 48K Apple with disk and Applesoft in ROM. $150. Rainbow Computing. Inc.. 9719 Reseda Blvd.. Northridge. CA 91324. (213)349-0300.

CIRCLE 353 ON READER SERVICE CARD

MUSIC & GRAPHICS

Rainbow Writer is a graphics. text. music and animation program development aid for the Apple. It can be used to create special effects featuring color. animation. letters. shapes and sounds. $39.95. Personal Software. Inc.. 1330 Bordeaux Dr.. Sunnyvale. CA 94086.

CIRCLE 354 ON READER SERVICE CARD

Plot-80 is a plotting software package for both dot matrix and daisy wheel printers which is available for use on the TRS-80 Model I with 48K RAM. one disk drive and a graphics printer. It is designed to plot graphs and histograms of various types. with numbered and labeled axes. $99.95. MicroComputer Specialists. P.O. Box 11295. Elkins park. PA 19117. (215)849-2766.

CIRCLE 355 ON READER SERVICE CARD

Muse has introduced the **Data Plot Graphing Program** for the 48K Apple with Applesoft in ROM. Its displays range from single line or bar charts to multiple line. additive bars as well as mixed line and bar formats. $59.95. Muse Software. 330 N. Charles St.. Baltimore. MD 21201.

CIRCLE 356 ON READER SERVICE CARD

PERSONAL

E.B.G. & Associates has announced two software packages for the TRS-80 Model I. **Program of Lists** allows the user to store up to 20 different lists of things to remember. $19.95. **Pentad Disk Library** maintains a library file of up to 100 diskettes which may be searched for any file name or partial file name. $19.95. E.B.G. & Associates. 203 N. Wabash. Suite 1510. Chicago. IL 60601. (312)782-9750.

CIRCLE 357 ON READER SERVICE CARD

UTILITIES & MISCELLANEOUS

UPROC1 contains procedures and functions to read and write device

registers on various interface boards, provide reboot capabilities from any Pascal program to any Apple operating system; supply a calibrated program delay for a variable number of milliseconds; support several types of character conversion; open new and exisitng files with standard reporting of UCSD Pascal I/O error messages; and allow flexible, user-defined tokenizing of strings. Analytic Solutions Incorporated, P.O. Box 13091, Research Triangle Park, NC 27709.

CIRCLE 358 ON READER SERVICE CARD

A **Master Catalog** system to keep track of all files on all disks in use is available on single-density 8" and 5 1/4" discs for CP/M users. $10. Elliam Associates, 24000 Bessemer St., Woodland Hills, CA 91367.

CIRCLE 359 ON READER SERVICE CARD

Faster for the TRS-80 Model I is a speedup facility for disk Basic programs. It analyzes executing programs and displays or prints information that enables the user to make appropriate changes. Prosoft, Box 839, N. Hollywood, CA 91603. (213)764-3131.

CIRCLE 360 ON READER SERVICE CARD

Mint Software announces three programs on cassette for the 16K TRS-80 Color Computer. **Renumber** provides the ability to load a program, renumber it and then save it; **Squeeze** will compress Basic code; and **Merge** allows two separate programs on cassette to be concatenated in memory and then saved. $19.95. Mint Software, 6422 Peggy St., Baton Rouge, LA 70808. (504)766-2318.

CIRCLE 361 ON READER SERVICE CARD

Microstat is a file-oriented advanced statistics package which includes a data management subsystem which allows the user to list, edit, destroy, delete cases, augment, sort, rank order, lag, move, merge and transform existing data into new data. The program requires 48K, one 8" disk drive, CP/M and Basic-80. It is also available for North Star DOS and Basic. $250. Ecosoft, P.O. Box 68602, Indianapolis, IN 46268. (317)283-8883.

CIRCLE 362 ON READER SERVICE CARD

Dirindex is a disk utility program which produces an index of individual listings which identifies the file by name/extension, indicates the size of the file in grans, and specifies a disk number and name. It requires a TRS-80 Model I disk system with 32 or 48K. $19.95. Programs Unlimited, Inc., 125 South Service Rd., Jericho, NY 11753. (800)645-6038.

CIRCLE 363 ON READER SERVICE CARD

ComputerMat has released a series of software on disk for the Apple called **Apple Sack**. Each Apple Sack has from 8 to 40 programs and retails for $24.95. Programs in the series include business and home applications, utilities, games, and simulations. ComputerMat, Box 1664F, Lake Havasu City, AZ 86403. (602)855-3357.

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ESP Computer Resources announces three software products for the Apple: **dataKEYper** is an interactive, data management system packaged with intelligent information management features ($99); **bookKEYper** is a basic business accounting system ($449); and **Personal budgetKEYper** includes software for checkbook management, personal bills and payables as well as expense statement and summary reporting ($195). The programs are available on 5 1/4" and 8" floppy disks and require a 48K Apple with two disk drives and Applesoft, DOS 3.3 or the language system. They are also available for Corvus 10 Mb disks. ESP Computer Resources, 9 Ash St., Hollis, NH 03049. (603)465-7264.

CIRCLE 365 ON READER SERVICE CARD

Macrotronics has announced a disk-based **Mailbox RTTY system** for the TRS-80 Models I and III with 32K RAM and one disk drive. The program is said to turn the TRS-80 disk system into a sophisticated RTTY communications terminal. $150. Macrotronics, Inc., 1125 N. Golden State Blvd., Turlock, CA 95380. (209)667-2888.

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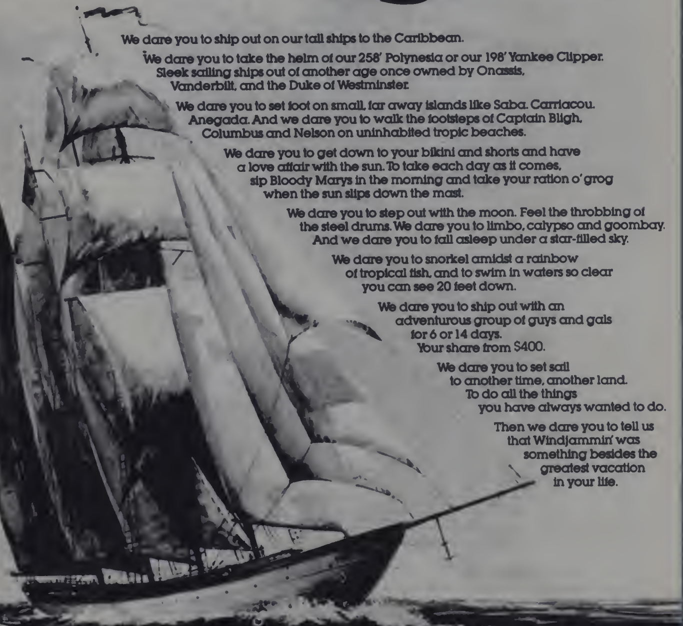

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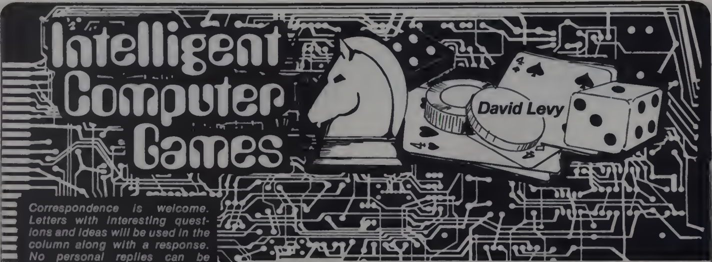


Correspondence is welcome. Letters with interesting questions and ideas will be used in the column along with a response. No personal replies can be made. Send to. David Levy, 104 Hamilton Terrace, London NW8 9UP, England

This month we are going to take a look at the game of Reversi (which has recently become known as "Othello"). In my opinion this is one of the best games ever invented, simply because the rules can be learned in no more than one minute, yet the game can take years to master. It is more complex than checkers but far less so than chess. And it is great fun to play.

Reversi was invented in England during the early 1880s, so it should now be celebrating its centenary. The game is played on an 8 x 8 board with discs which are black on one side and white on the other. The players move alternately until the board is full or until neither side may make a move, at which point the player with the most discs on the board is the winner. If a player reaches a position in which he has no moves at his disposal, he must pass, and the right to move is returned to his opponent.

In order to make a legal move a player must put down a disc with his own color uppermost, so that the disc being put down and another of his discs which is already on the board, contain between them an unbroken line (horizontal, vertical or diagonal) of his opponent's pieces. These pieces showing the opponent's color are then flipped over and now belong to the player who has just moved, but they may be flipped back later by a move made by the opponent. If the disc being put down forms more than one "sandwich," all the sandwiched discs are flipped.

The first four moves must all be made in the four central squares of the board, d4, e4, d5 and e5, and herein lies the one and only difference between Reversi and "Othello." In Reversi, the two players may choose where they play within these four central squares. Thus, the player who moves second may either (a) force his opponent to have the first two moves in a horizontal or vertical line; or (b) offer his opponent the choice between (a) and a diagonal line. Black moves first and if he decides to put a disc on d4, white could force him to play in a horizontal or vertical line by himself playing on the only diagonal spot, e5. Or white could leave the choice open by playing on e4 or d5.

In Othello, which was "invented" in Japan during the early 1970s, black starts the game with discs on d4 and e5, white with discs on e4 and d5. If this really is a new game then I have just invented a wonderful game called David Chess, in which the rules are exactly the same as in normal chess except that white must make his first move on the king's side. (Incidentally, Kevin O'Connell has invented another game called Kevin Chess, in which white must make his first move on the queen's side. We are both going to patent our games and try to make as much money out of the licensing fees as did the man who "invented" Othello.)

8								
7								
6								
5				W	B			
4				B	W			
3								
2								
1								
	a	b	c	d	e	f	g	h

Diagram 1.

Since the principles of playing Reversi and Othello are identical, we shall now refer to the games under the combined name of Reversi/Othello.

How to Play a Good Game

Having explained the rules of the game, we should now examine some of the more important principles or heuristics of good play. Diagram 1 shows the initial position of Othello, in which black may play on d6, c5, e3, or f4. All of these moves are nothing more than reflections of each other, so the decision as to where black should place his next disc is completely immaterial. I would suggest that your program choose between the four squares at random, so that the human player will be faced with a visually different board position more often.

The first principle of the game is that it is the end result that counts, not who has most discs on the board during the earlier parts of the game. In fact it is very often the case, particularly in games between a beginner and an expert that the beginner has the vast majority of discs until near the end of the game, and he finally loses by an absolutely enormous score. One reason for this is that until the very final stages of the game, material (i.e., the relative number of white and black discs on the board) is much less important than structure (where your discs are situated) and mobility (how many moves you have at your disposal). If you have a lot more discs than your opponent, he will tend to have the greater mobility, so it is usually the case that a strong player will try to minimize the number of discs that he turns during the first part of the game. Of course this strategy can be taken too far. One Othello program which is commercially available, recently lost two games in a tournament when it turned so few discs that its opponent scored a clean sweep during the first 20 moves. Such accidents are rare, but your program should prevent them.

Material and mobility are easy to measure, but structure is much more complex. Certain aspects of structure are obvious, and these help us to formulate a sensible strategy. For example a disc on a corner square can never be captured, so it can form an ever growing base from which its owner can expand outward unmolested. For this reason the player who first captures a corner very often wins the game. Since a corner square is so desirable, it is

Games, continued...

very disadvantageous to place a disc on any of the squares b2, g2, b7 or g7, since this always leads to the loss of the adjacent corner, when the opponent gets one of his own men on the long diagonal for just long enough to make a sandwich that includes the b2/g2/b7/g7 square. Similarly, the squares b1, a2, g1, h2, b8, a7, g8 and h7 are undesirable, as they allow an opponent to creep along the edge and finally capture the adjacent corner. On the other hand, since a1 is such a good square and b1, b2 and a2 are so bad, it is obviously desirable to have discs on c1, c3 and a3, so that one day the opponent will be forced to capture these discs, putting his own disc on b1, b2 or a2, and you will be able to recapture, putting your disc on a1.

This analysis of structure can be continued, by placing greater value on the squares d3 and e3 than on c2, d2, e2 and f2, on the grounds that if a player occupies the 3rd rank, when his opponent occupies the 2nd rank, he will be able to make a capture on the edge of the board, and edge squares are worth having. In fact the value of edge squares is an extremely complex subject, well beyond the scope of this article. Suffice it to say that a lot of erroneous ideas have been expressed about edge squares. Certainly b1 and a2 are bad squares to occupy from the structural point of view, but in fact it is edge formations that are really important, and not individual edge squares.

How the Game Changes

The nature of the game changes as more and more discs are added to the board. In the early stages (the opening) and the middle-game, structure and mobility are all important, but in the final analysis it is the player with the most discs on the board who wins the game. It is therefore clear that up until a certain point in the game, structure and mobility should be the most heavily weighted features in the evaluation function, while during the last few moves the evaluation should become more and more oriented toward the number of black and white discs actually on the board. One way in which this might be accomplished is to have an evaluation function of the form:

W_1 x (Mobility + k x Structure) + W_2 x Material

where $W_1 = e - nz$ and $W_2 = (1 - 3 - nz)$

n=number of discs on the board
k and z are constants

When the number of discs on the board was low, i.e. during the early stages of the game, W_1 might be just below 1, while near the end of the game, when n approached 64, W_1 approached O.

Quantifying the Features

Mobility is easy to measure, being merely the number of moves available, but in a tree searching program the matter is not so simple. The reason for this is that after a white move, it is possible that white has a very low mobility because he has just made a number of captures (i.e. flipped a number of black discs), whereas after black's reply move white might have a much higher mobility because black has flipped a number of discs back. It is therefore rather meaningless to compare mobility evaluations at odd and even ply, so the tree should be searched to a uniform depth, or at least all terminal nodes should be either at odd or even ply. In this way the program can happily compare its mobility in different positions, whereas were it to compare the mobility after a white move with the mobility after a black move, the answer would be meaningless.

Material is also easy to measure, being merely the count of how many white and black discs are on the board. The most difficult problem is how to measure the structural aspects of the position. One obvious method, which has gained wide support, is to weight the squares of the board in some way that reflects which ones are desirable and which ones should be avoided. A simple weighting map is shown in Figure 2.

8	16	−4	4	2	2	4	−4	16
7	−4	-12	−2	−2	−2	−2	-12	−4
6	4	−2	4	2	2	4	−2	4
5	2	−2	2	0	0	2	−2	2
4	2	−2	1	0	0	2	−2	2
3	4	−2	4	2	2	4	−2	4
2	−4	−12	−2	−2	−2	−2	−12	−4
1	16	−4	4	2	2	4	−4	16
	a	b	c	d	e	f	g	h

Diagram 2. Possible square weightings to reflect good and bad squares.

All things being equal, which they never are, the map in Figure 2 represents an acceptable valuation of individual squares, but the problem is made more complex by the fact that occupation of one square may well change the desirability of occupying some other square and this change might have an effect of fatal proportions. A simple example is the question of the b2 square. It is very bad to occupy it, because occupation of b2 might lead to the loss of a1, but if you already occupy a1 then b2 can do you no harm. A map of square values must therefore change dynamically as the game progresses, and your program should be able to cater to these changes.

The Openings

Othello is not yet sufficiently well analyzed for us to be able to tabulate the best and worst openings, but that is not to say that we cannot make some definitive remarks about opening play. Indeed, it is quite possible for your program to build up its own openings library, given one or two elementary principles.

We have already discussed the subject of mobility. Another aspect of opening play, which is widely regarded as being important, is the apparent undesirability of being the first player to place a disc outside the central 16 squares. The reason for this is rather obvious—if you are the first to place a disc one rank or file away from the edge, your opponent will probably be the first player to place a disc on the edge of the board, and edge squares are important. Therefore, if your program could analyze exhaustively the first 12 moves of the game (remember that there are four discs on the board at the start), it could determine which side was ahead in mobility in every variation, and it could also select the move or moves which gave the best chance of being the first to place a disc on the edge of the board. This exhaustive 12-ply search might take a great deal of time, but it would only need to be done once, and the results could be printed so that you would be able to construct an openings book comprising optimal play (at least, optimal in the context of this strategy). Then, even though your program might only be able to perform a 3-ply or 4-ply search during the game, it could play the first few moves on the basis of the exhaustive 12-ply search.

I should perhaps add that it is not yet known the extent to which the "Sweet 16" strategy is likely to be successful, but that combined with a mobility feature should enable your program to write a strong openings book.

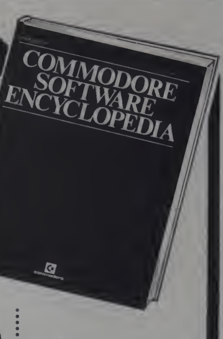
The Middle-Game

We have examined the form that a Reversi/Othello evaluation function might take, and it only remains for the reader to select his weightings, which he can perhaps do on a learning basis. The small number of independent parameters (W_1 k and z) makes it relatively easy and quick to play a large number of text games in which one version of the program employs one set of parameters while its opponent uses another set. At the end of a series of such games, the programmer can select optimal weightings. (Once again, let me remind you to ensure that in its quest for high mobility your program does not give away all of its discs.)

The Endgame

Since the total number of discs on the board is the final and absolute criterion for determining the winner, it is clear that your program should, during the last few moves, search the game tree to its very end, and apply only material as its evaluation feature. How far from the end of the game an exhaustive search is possible will

HERE IT IS!!!



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depend upon the speed of your processor and the efficiency of your program. For this reason, it is doubly important to have an efficient move generation routine. The advantages of being able to search the whole of the game tree from zero or eight moves prior to the end of the game, are rather obvious.

How to Write an Othello Program

This article contains all that you need to know to be able to devise a suitable evaluation system for the game. Your program will be a traditional tree-searching program, employing the alpha-beta algorithm and all the tricks associated with it (alpha-beta window; killer heuristic; iterative deepening; move sorting; etc.) Some of you may have missed my earlier articles in which I went into great detail over these essential elements of game playing programming, and I would strongly urge you to beg, borrow or even buy the back numbers of this magazine so that you will be properly acquainted with all the principles of tree-searching, otherwise most of my articles will be lost on you.

Just how strong are the best Othello programs compared to the strongest human players? Since the game is quite complex in nature, and humans have more difficulty envisaging board positions after a number of discs have changed color and changed back again (and again, and again), the relative difference between the best humans and the best programs should be much smaller than is the case in, for example, the game of chess. And that is exactly how things are. The world's strongest human players are not demonstrably better than the best Othello programs, and I would guess that within a year or two there will be programs which will never lose a game to a human.

In order to test the world's best human players against good Othello programs, Professor Peter Frey of Northwestern University, Evanston, IL (home of the famed CHESS 4.n programs), organized a man vs. machine tournament on June 19, 1980 at the Northwestern campus. Six Othello programs were pitted against the two top ranking human players in the world, Hiroshi Inoue of Japan (the current World Champion), and Jonathan Cerf of the USA (runner up in the previous World Championship but winner of the title in October 1980). The result of the tournament was a win for Inoue, but he did lose one game, to a program written in London named The Moor. Cerf also lost a game, to a program written by Dan and Kathe Spracklen of Sargon fame. Since June the programs have all been debugged to some extent, and I imagine that if the tournament were to be replayed the humans would have much more difficulty finishing at the top.

To produce programs that can play this well normally requires a substantial commitment in man hours. But there is no reason why the readers of this magazine cannot write a program to play at or near expert level. Mike Reeve, who programmed The Moor, did not even know how the pieces moved when he began working on the game, so although some advice from a strong player is very useful, you can achieve quite a lot with the information I have given you.

The following games show The Moor in action, and illustrate some of the finer points of Othello/Reversi.

8	B	B	B	B	B	B	B	
7	B	B	W	W	W	B	B	B
6	B	B	W	W	B	B	B	B
5	B	B	W	B	B	B	W	B
4	B	W	B	W	B	B	B	B
3	B	B	B	B	W	B	B	B
2			B	B	B	B	B	
1			B	B	B	B	W	
	a	b	c	d	e	f	g	h

Diagram 3.

First a position, taken from a game in the 3rd Othello/Reversi tournament for computers organized by the French Magazine "L'Ordinateur Individuel," in May 1980. In this game The Moor, searching to a depth of only 2-ply, had fallen afoul of a program looking to 6-ply (The Moor was a development version, written in Pascal). Black, our opponent, has just made a mistake, and I give this position only to illustrate the point that having a large number of discs on the board is not always a good idea, even near the end of the game. Look what happens now, from a position in which black is "winning" by 46 discs to 11, with only seven squares left to play on. We begin with white's play at move 58: (white moves are W, black moves are B)

54 W b1
55 B PASS
56 W h8
57 B PASS
58 W h2
59 PASS
60 W h1
61 B PASS
62 W b2
63 B a2

and now neither side may move again, so the game ends, with white having 39 discs to black's 24.

The previous example shows just how easy it is to be deceived into thinking that having a big material advantage is decisive. In the next game, for which you will need an Othello set if you wish to follow it properly, black gets into serious trouble from early on, and then makes a serious mistake which costs him the first corner. This game was played at the finals of the 1980 British Othello Championships in London, immediately after Neil Cogle won the Championship title. It illustrates my argument that a computer program can already play at the same level as top human players.

Black: Neil Cogel (1980 British Othello Champion—for humans!)
White: The Moor (4-ply look ahead)

1 B c5
2 W e6
3 B f5
4 W c4
5 B c3
6 W d3
7 B f4
8 W b3
9 B b4
10 W c6
11 B d6
12 W a4

So The Moor has gained the first disc on the edge of the board, and to redress the balance Black takes the dangerous square a2.

13 B a2
14 W f6
15 B e7
16 W f8
17 B b5
18 W e3
19 B f7
20 W a5
21 B a6

Black was already in a bad way, with a disc on a2 and a deficit in mobility, but this move is a fatal mistake which puts his position beyond repair. See if you can spot The Moor's killing reply.

8						W		
7					W	B		
6	B		W	W	B	B		
5	W	B	W	W	W	B		
4	W	W	B	W	W	B		
3		B	W	W	W			
2	B							
1								
	a	b	c	d	e	f	g	h

Diagram 4.

22 W a3

Now you can see the danger of playing on a2. Black must lose the a1 corner.

23 B d8
24 W b6
25 B c7
26 W a1

Now that The Moor has a corner, it uses the corner as an impregnable base from which to expand its control of the board.

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Games, continued...

27 B f3
28 W g3
29 B f2
30 W g4
31 B h5
32 W e2
33 B e1
34 W d2
35 B h4
36 W d7
37 B c8

White can afford to concede virtually every edge square at this stage of the game, in the knowledge that his corner anchor on a1 will eventually allow a clean sweep of the edges.

38 W g1
39 B d1
40 W g6
41 B h6
42 W g5
43 B c2
44 W b1
45 B b2

Now that a1 is already occupied, putting a disc on b2 is relatively unimportant.

46 W a7
47 B g2

There is no way that white can be kept out of h1. If black plays on f1, white replies on c1 and then black is forced to play on b7 and g2 within the next few moves.

48 W h1
49 B h2
50 W f1
51 B b7
52 W c1
53 B PASS

Black has no moves, and white continues its march around the edge of the board.

54 W h3
55 B PASS
56 W h7
57 B PASS
58 W g8
59 B g7

Black's problems are aggravated by the fact that by now The Moor is examining the whole of the game tree exhaustively, and is always making the very best move.

60 W h8
61 B PASS
62 W e8
63 B PASS
64 W b8

Neither side may move to a8, so the game comes to an end with The Moor winning by 61 discs to 2, which is rather like being several queens up at the end of a game of chess.

Finally, I shall give without comment the game won by The Moor against World Champion Hiroshi Inoue of Japan on June 19, 1980. The final score in this game was 36-28 in favor of the program, and not 34-30 as reported in the tournament bulletin.

Black: The Moor
White: Hiroshi Inoue

1 B d6	31 B c8
2 W c6	32 W g5
3 B c5	33 B h6
4 W c4	34 W h5
5 B b3	35 B h4
6 W e6	36 W g6
7 B c7	37 B h7
8 W b5	38 W c1
9 B a6	39 B d2
10 W c3	40 W b2
11 B c2	41 B d1
12 W b4	42 W e1
13 B f4	43 B e2
14 W f5	44 W f1
15 B f3	45 B f2
16 W e3	46 W b1
17 B a3	47 B g8
18 W d7	48 W g1
19 B d3	49 B b7
20 W g4	50 W a7
21 B f6	51 B g2
22 W a4	52 W g3
23 B d8	53 B h1
24 W b6	54 W h2
25 B a5	55 B a1
26 W e7	56 W h8
27 B h3	57 B g7
28 W e8	58 W b8
29 B f8	59 B a8
30 W f7	60 W a2

Black wins by 36-28.

To the best of my knowledge, this is the first time that a computer program has ever defeated a human World Champion in a game of pure skill.

Bibliography

Unfortunately there are, as yet, no good books on Othello. I should perhaps warn readers about a book translated from the Japanese, with the collaboration of Maxine Brady (whose book on Monopoly is excellent). This Othello book contains the rather puzzling advice that it is a bad thing to have too many discs more than your opponent, and it is also a bad thing to have too many discs fewer than your opponent. It seems to me that if one is good, the other ought to be bad! □

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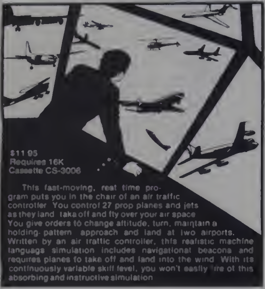

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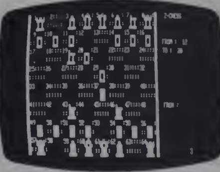

This is one of the most sophisticated computer chess playing programs available today. Seven different skill levels provide practice for the beginner as well as challenge the more experienced players. The speed of Z-Chess will also surprise you. Even at the highest skill level it is one of the fastest chess programs available.

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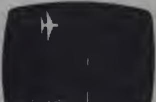

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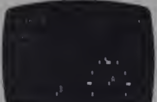

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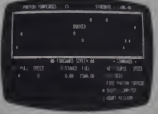

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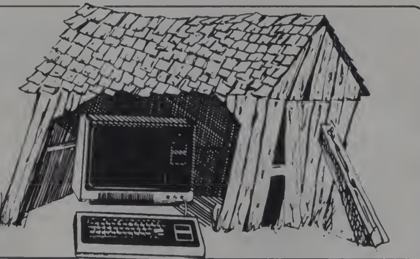


Stephen B. Gray

For column 30, let's take a closer look at the TRS-80 Pocket Computer, check out two Radio Shack programs for the PC, consider three computing axioms, examine a graphics editor, and peek at a short graphics program.

TRS-80 Pocket Computer

After a few introductory words about the Pocket Computer (Nov. 1980, p. 184), it's time to take a closer look at what we'll call the PC for short.

In that November column I said Radio Shack would probably sell more of the PCs than the Model II and the Color Computer. That was written before I knew the Model I would be discontinued.

The market for the six-ounce $249 PC (made for Radio Shack by Sharp Electronics Corp. in Japan) seems to be split three ways. First, there is the gadgeteer—the person who wants the PC because it's such a clever little piece of engineering, or who wants to be the first kid on his block to have one.

Second is the man on the road whose job requires a lot of travel, and who can't pack along a Hewlett-Packard HP-85 or some such table-top micro. The PC is just the thing for a surveyor, real-estate salesman, insurance salesman, field engineer, or anybody who needs a highly portable and easily programmable computer. Three of the first eight programs Radio Shack offered for the PC are called Real Estate, Civil Engineering, and Aviation.

Third is the science of engineering student, who needs to make complex computations in chemistry, physics, engineering, etc.

For these last two categories, the PC has some competition from calculators that can read in a program from an easily inserted magnetic strip (such as the HP-67), or from a single plug-in ROM (such as the TI 58C), or both (such as the TI59). Reading a program into the PC from tape involves two additional pieces of equipment: the cassette interface and a tape recorder.

One big advantage the PC has over all those HP and TI calculators mentioned (except the TI 58C) is that it retains your programs in memory even after you turn it off. It also displays 24 characters, instead of only half that many.

Taking these and other factors into account, we won't know how well the PC is selling until Radio Shack announces that it has sold 100,000, or maybe 200,000 or them. They didn't reveal any figures on the Model I until 200,000 had been sold.

The PC, by the way, uses two four-bit CMOS microprocessors, one for arithmetic operations, the other for the Basic interpreter and key-in. The 11K of ROM memory are split between 7K for the Basic interpreter, and 4K for the monitor. There's also about 1.9K bytes of non-volatile CMOS RAM memory that automatically abbreviates Basic words into tokens, to make the most of memory.

PC Manual

Radio Shack has again done a freelance writer a good turn by providing for the PC the same kind of reference manual they did for the Model I Level II TRS-80. At least three or four writers are undoubtedly working on better versions of Radio Shack's 124-page 26-3501 manual.

Perhaps I should say "working on simpler versions," because the manual is good if you've already had some programming experience with another TRS-80 or some other computer. However, many beginners will find the manual too compact, starting right off with a five-page Table of Functions and Statements that will mystify most people who've never used a computer.

In fact, page 31 even says "Since this Manual is not intended to be a simple learner's guide to Basic Programming, if you feel we are moving along too fast, we urge you to stop by your local Radio Shack store and obtain a copy of either (or both) of the following books," and then lists the 60-2016 and 60-2015 books, both of which are entirely about Model I Basic. Even someone who's had TRS-80 experience might have trouble understanding some of the all-too-short sections on DEBUGging programs, PAUSE, BEEP, MEM, etc.

There are some things the manual doesn't tell you. For example, because the PC searches for variables from the last (Z) to the first (A), it accesses the variable X faster than the variable A, and therefore if you want to speed up programs that frequently access a variable, use the letters at the end of the alphabet. To assign A=1 takes 78 milliseconds; to assign Z=1, 62 milliseconds. (Thanks to Don Inman for these figures.)

The manual doesn't tell you what to do if the keyboard locks up (which hasn't happened to me yet, and I don't know how to make it lock up): you turn the PC over and press a ballpoint pen into the hole below the ALL RESET label. This wipes out everything in memory—including all your stored programs.

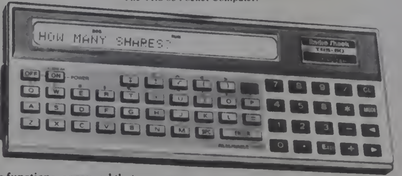
Something else the manual doesn't tell you (although pages 47 and 50 hint at it) is that the memory in the PC is used from both ends: program steps from one end, and data from the other. When they meet in the middle, the memory is full.

So the memory can be thought of as a continuous memory, 1,632 bytes long. You can fill the entire 1,632 bytes with data, although they would be useless without a program. But if you're writing a long program, you can't exceed the 1,424 bytes of flexible memory, because the 208 bytes of fixed memory are for data only, with 26 data memories for storing A to Z, or A$ to Z$, or A(1) to A(26), etc.

PC Functions and Statements

The Pocket Computer has three dozen functions and statements you'll recognize from Level II Basic, but it doesn't have ON/GOTO, READ, DATA, RESTORE, RND, AUTO, EDIT, POKE, PEEK,

The TRS-80 Pocket Computer.



string functions, or several that are meaningless without a screen, including CLS, TAB, SET, RESET, POINT and PRINT @.

The PC does have a few statements not found in Level II Basic including DMS (degree/minute/second), DEG, PAUSE, BEEP, DEGREE, RADIAN, GRAD, AREAD, and CHAIN.

Reservable Keys

One feature of the PC that none of the bigger TRS-80s has is reservable keys, which are the 18 keys on the lower half of the keyboard. Any one of these keys can be used to call up an entire program or an often-used function.

To use a reservable key, you press the MODE key to get into RESERVE mode. Just press the yellow SHFT key and then one of the 18 reservable keys, and anything you key in before pressing ENTER will be stored for later recall, using the reservable key.

For example, you might assign

A*A+B*B

to the S key, so that later, when you're writing trig programs that use this sum of squares, you need only press SHFT and S, to call it up, and thus use only two keystrokes instead of seven.

The reservable keys can also be used to turn the PC into a $249 memo pad; you can use them to store up to 18 phone numbers and/or addresses, or formulas, or whatever. The PC comes with two plastic overlays that fit over the lower half of the keyboard, so you can "identify the functional operations assigned to the reversable keys or defined programs assigned to the definition keys," as the manual puts it.

In defined mode, you assign each of the programs you put into memory to one of the 18 keys, and later you can execute each program separately by pressing SHFT and the key, while in the DEF mode.

Unique

The Pocket Computer's Basic may be the only one that allows you to omit the multiplication asterisk in certain cases, thus saving much space when you're doing a lot of multiplying.

So, instead of using

2*A, 3* π, B*A(12)

you can leave out the * and use

2A, 3 π, BA(12)

but, of course, you can't use

3 5

instead of

3*5.

Editing

Editing with the PC is simple: you use two keys to move the cursor left or right; the same two keys in shift mode will let you insert or delete characters. Up-arrow and down-arrow keys let you examine any program line, and the left-arrow and right-arrow cursor-control keys let you look at all of any program line longer than the maximum of 24 characters that can be displayed on the LCD panel.

Problems

In making the Pocket Computer so small, Sharp had to sacrifice some of the conveniences of a larger computer. The keyboard is so small you can use only one finger at a time, or two if you set the PC on a non-slip surface. (Incidently, Sharp is going to market the PC under the Sharp label shortly, "at a competitive price." It'll be interesting to see what kind of a manual they produce to go with it.)

The PC tape format and baud rate aren't the same as the Level II TRS-80's, so you can't prepare a tape on the more convenient Level II keyboard for loading into the PC. Nor can you load into a Lever II TRS-80, for processing, a PC tape of mostly data you've made in the field or a PC tape you want to LIST out. This is, of course, aside from the problem of several incompatible Basic statements and functions.

However, these and other problems aside, the TRS-80 Pocket Computer is a natural for anybody who wants a maximum of computing power in a minimum of space.

Incidently, there's one character not indicated on the PC keyboard. Press SHFT and Y, and you get what looks like a Y overprinted with an equal sign. What is it? The Japanese sign for yen. Used for Japanese strings?

Real Estate Programs for PC

For $24.95, you can buy a Radio Shack software package consisting of a manual and two cassettes containing six programs for the real-estate investor and agent. The six programs are Savings and Loans, Interest Calculations, Commission Tracking, Loan Amortization, Cash Flow Analysis, and Depreciation Analysis.

To use these programs with your PC, you'll need the $49 cassette interface and a cassette recorder. Although the $79.95 Minisette-9 is a neat little machine, you can use the CTR-41 that came with the first TRS-80s, or any similar recorder.

Loading the real-estate programs is fairly easy. You plug the PC into the interface, and plug the cables from the interface into the recorder. Entering CLOAD "REAL1" will load in the first program, in about 2 3/4 minutes, in DEF mode.

There's no winking asterisk to let you know you're at the proper volume level, but you can hear the "bit stream" because it's also routed to the piezoelectric beeper that's activated by a BEEP statement, to let you know a program is being read from the tape.

Just as in the Level II TRS-80, you use a CLOAD? to "verify that the program on tape and the program in the PC are identical."

Press SHFT and A, and

ENTER U FOR UNKNOWN

is displayed briefly, followed by RATE (%), # PERIODS?, PAYMENT?, PRE-PERIOD PMT? (Y/N), and FUTURE.

The Savings program calculates any unknown factor if given the three known factors. So if you enter 6.25/12 for the monthly RATE, 12*5 for the total number of payment PERIODS, 25 as the monthly PAYMENT in dollars, Y for PRE-PERIOD PMT because the payments are made at the beginning of the period (month), and U for FUTURE, you'll find out how much you'd have after five years of depositing $25 a month into an account that's compounded monthly at an annual rate of 6.25 percent.

After you've entered all the factors, the PC display soon reads

FUTURE $ 1764.65

Press ENTER and the display changes to

TOTAL PMTS $ 1500.

Press ENTER once more, and the display becomes

INTEREST $ 264.65

Press ENTER again, and you're back to RATE(%)? for another round.

And so it goes, to compute interest rate, number of interest periods, required deposit, monthly loan payments, loan value, balloon payments, and many more.

The small manual gives an example of every computation for every way in which each program can be used, explains the meaning of all terms such as future and balloon, tells how to make backup tapes, and how to keep the PC in good shape.

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Aviation Program for PC

The $24.95 Radio Shack Aviation Program is a collection of seven commonly used aviation calculations and eight conversions. All 15 come in one cassette and are stored in the PC at one time, and each formula can be called by pressing SHFT and one of 15 defined keys. The package includes a plastic overlay that fits over the lower two rows of keys and is printed to show what each key controls.

The conversions are between centigrade and fahrenheit; statute miles and nautical miles and kilometers; and U.S. gallons and imperial gallons and liters. The calculations are for true altitude, true airspeed, mach number, off-course correction and drift angles, true headings and ground speed with winds; and enroute winds.

To get a conversion, simply enter the number to be converted, then press SHFT and the appropriate conversion key. The calculation programs will request specific information first.

The manual give examples of some conversions, with practice problems, and examples of all calculations; it also tells how to make a backup copy, how to take care of the PC, and lists the functions, abbreviations and variable assignments.

This last list is handy when you want to recall an answer without having to recalculate it; all the results of calculations and conversions are stored in the 26 variable registers for later use. Of course, new answers on calculations will automatically replace the previously stored answers.

Computing Axioms

In looking over past issues of CLOAD, the cassette magazine, I came across "McElroy's Three Axioms of Computing," in the June 1980 issue. Ralph McElroy used to be the publisher of CLOAD, before he went back to Texas and hardware. The axioms:

1. If a 3 x 5 card file works, use it. It's faster and more reliable.

2. All problems are always in the software. All of them. Always. Always.

3. If you feel you're in danger of being replaced by a computer, you're probably overestimating the ability of computers, and therefore your fears are probably groundless. Corollary: If you can be replaced by a computer, you should be.

Ralph calls these three "simple Truths to guide you in your computering." I quoted his first axiom recently to a publisher who'd asked me to look over a manuscript on the TRS-80 Pocket Computer. The author presented a list of 31 ways to use the PC, but two-thirds of them are trivial and are more easily handled with pencil and paper or file cards, such as shopping lists, memo pads, 100 most misspelled words, cueing for speeches, reference tables, etc. These all use the PC as a memory aid, not as a computer.

Graffit 2.0

A fairly powerful graphics editor in Basic for the TRS-80 16K Level II computer is available from Brunswick Computer Software (8 Teesdale St., Moncton, NB, Canada E1A 5K5), for $15 ($17.95 Canada) on disk, and $10.95 ($12.95 Canada) on cassette.

You get a run version, a documented version (jam-packed with REMs), a source listing of the documented version, a constant/variable cross-reference listing, and a set of instructions.

As the instructions put it, Graffix 2.0 "is a multipurpose program with applications for programming, animation, and just plain doodling. It is simple enough for a child to enjoy and sophisticated enough for advanced applications."

The primary operating mode is Doodle Mode, which uses single keys to draw (or erase) lines in the eight major compass directions. Two other keys act as flip-flops to control SET/RESET and continuous/single-pixel.

For example, to draw a line from 0,0 to 127,0 you press G for continuous drawing, and H for the eastward vector. That's all; the line is drawn for you.

To erase the line, you can enter PQ, which erases the entire screen, or press E, which flips the control to RESET, and then F, which is the westward vector, and the line is erased.

The speed of drawing and erasing can be controlled by pressing any of the number keys during drawing, with 0 providing the fastest speed, 9 the slowest.

The complex subroutines are called by two-letter codes beginning with P. Enter PT, and you can create strings up to 255 characters long, any of which can be accessed by a single key when you're in PS (editor) mode. Any combination of ASCII, graphics and control characters can be included in the strings.

Here's a simple graphics program created with Graffit 2.0:

```
C16(42+26+24)
D8(191+26)+8(191+26+2(24))
EC+D
F3(E+8(25))
```

First, turn to page C/1 in your Level II manual, if you're not familiar with "Functions 1-31."

String C, which you could just as easily call string A or string Q, generates a vertical row of 16 asterisks. The ASCII code for an asterisk is 42; the function code for a downward line feed is 26, and for a backspace cursor is 24. Without the 24, the row of asterisks wouldn't be vertical, but would lean about 15 degrees to the right, from top left to bottom right.

String D creates a large "greater than" sign, using the solid, six-pixel graphics character whose code is 191. First the string lays down eight of those solid blocks in a line that slants toward the right (remember, without the 24 code, the line will slant), then eight more in a line that slants back to the left (since the TRS-80 automatically spaces after displaying a character on the screen, two backspaces are required to put the next solid block one space to the left of the block above it).

String E concatenates strings C and D, adding them together to create a large triangle. String F creates three triangles in a row, eight spaces apart (code 25 advances the cursor one space to the right).

The Graffit 2.0 program includes error codes to let you know if you've omitted a parenthesis, or have entered too many strings for the amount of memory you have, etc.

The PU subroutine saves the contents of the screen by putting it into a Basic program that will print out your graphics creation.

The PW subroutine provides animation by displaying the user-defined strings in rapid succession in an infinitely-repeated loop, until a key is pressed.

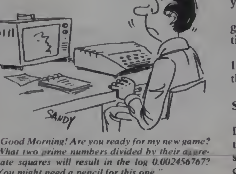
There are other subroutines, such as PX, which creates a four-way symmetrical figure with random graphics, PY, which prints the graphics on a BASE 2 printer, if you have one and several others.

The Basic programs that create your graphics can be incorporated as subroutines in other programs you write.

This is one of the best graphics editors I've seen and is a great help in simplifying the creation of graphics.

Short Program #18

Dan Rocha, a 16-year-old student at DeKalb High School in Dekalb, IL, sent this program, which has been rewritten to standardize the line numbers to fit this column width.



"Good Morning! Are you ready for my new game? What two prime numbers divided by their aggregate squares will result in the log 0.002456767? You might need a pencil for this one."

```
100 CLS
110 X=RND(64): Y=RND(24)
120 A=RND(5)
130 ON A GOTO 140,150,160,170,170
140 X=X-1: Y=Y-1: GOTO 180
150 X=X+1: Y=Y-1: GOTO 180
160 X=X-1: Y=Y+1: GOTO 180
170 X=X+1: Y=Y+1: GOTO 180
180 IF X<0 OR Y<0 OR X>127 OR Y>47
    THEN 230
190 IF POINT(X,Y)=-1 THEN 300
200 SET(X,Y): SET(127-X,Y)
210 SET(127-X,47-Y): SET(X,47-Y)
220 GOTO 120
230 B=RND(5)
240 ON B GOTO 250,260,270,280,290
250 X=64: Y=0: GOTO 120
260 X=0: Y=24: GOTO 120
270 X=64: Y=24: GOTO 120
280 X=0: Y=0: GOTO 120
290 X=32: Y=12: GOTO 120
300 RESET(X,Y): RESET(X,47-Y)
310 RESET(127-X,47-Y): RESET
    (127-X,Y)
320 GOTO 120
330 END
```

Dan wrote it originally for the Level I TRS-80. To convert the above Level II version to Level I, remove the minus sign in line 190, and change line 180 to

180 IF (X<0)+(Y<0)+(X>127)+(Y>47) THEN 230

The program creates a constantly-changing four-way-symmetrical pattern.

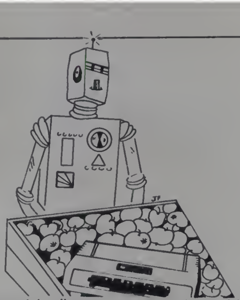
Line 110 randomly selects a starting point for the upper left quadrant of the pattern, which is continued diagonally in random manner by lines 120-170. Lines 200-210 make it a four-way symmetrical pattern.

If the pattern reaches the edge of the graphics area, line 180 switches the program to lines 230-290, which relocate the moving X,Y point to one of five places on the screen, selected randomly. The program then jumps back to line 120 to continue the diagonal pattern.

If the moving X,Y point reaches a graphics block that is already on, line 190 jumps to lines 300-310, which reset that block as well as the three others that make up the four-way pattern. □

"Yeah, this machine really does multiply!"

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.

This month the column will feature a review of the Videx Videoterm 80 column display board. After looking over the various boards on the market, my choice was the Videx board. There is a lot more to the board than the ads convey. A new book about Apple Machine Language has appeared on the market, and S-C Software is publishing a machine language newsletter called *The Assembly Line*. There will be the usual input from readers and answers to some of the questions you have asked. There will be some old things for the new owners and something for everyone.

Videoterm

There are at least five 80-column video boards on the market now. Each one has good and bad features. My choice was based on what I considered to be the best balance of attributes. The character set, ease of changing the character set, hardware features, compatibility with other Apple peripherals and languages, and accessories all influenced my choice. Here are my impressions.

What I Didn't Like

At first I didn't like the character set. Since the character set is easy to change, this didn't bother me. I've grown used to it now so there is no longer any pressing need to make it different. (Actually I would have made it look like the standard Apple II character set.) To use the board with Integer or Applesoft Basic, you have to make a call to the board to see 80 characters after you boot the system. An accessory board is available to let you switch between the two video outputs; first Apple II then Videoterm. The board appears to be designed more for use with the Language System and with the Microsoft Z-80 Softcard. These default immediately to the 80-column board at boot time.

Clearing the screen is another problem. You are supposed to be able to clear the screen with a control L. In Integer Basic, there is no easy way to do a control L. You can include one in a PRINT statement. But, when you do this, and then list your program, the first part of the listing disappears from the screen. Typing a control L at the keyboard does different things, too. Integer accepts it; Applesoft generates a syntax error. The way to do a control L in Applesoft is to use CHR$(12). This works as an immediate command and in a program as a deferred execution command. Note that you cannot use HOME except with the Microsoft Basic supplied with the Z-80 Softcard. CHR$(12) does not work with the Z-80 Softcard version of Basic. Also, there are several special features to control video output and the character fonts that will work with standard Apple languages but not with the Z-80 Softcard. Many of the items mentioned above are not problems; they will be inconveniences only if you switch frequently from one system to the other.

Features And Functions

Videoterm is a single board designed to be plugged into any expansion slot. The preferred slot is #3. It is a Hazeltine Equivalent Data Media system.

•Character Sets—There are two: a standard set including true descenders and an alternate set. Also, you can select either a 7x9 or a 7x12 dot font. If you select the 7x12 font with only a 7x9 character set in place you get an interesting "space-and-a-half" effect with the Apple Basics.

•Micromodem Compatibility—It's possible but not as-is. You will need to get the Hayes EPROM to make it work correctly. Some of the control characters used with Videoterm are the same as those used with the Hayes Modem. The new software won't change how the Modem works except with Videoterm. You will use different control codes when using Videoterm and you will give up the self test feature of the original software. Save the old ROM if you ever need to do the modem self-test again.

•Light Pen Input—A connector is provided for future light pen capability. There is no specific information available at this time.

•Customizing—You can make several changes to the board to suit you applications. The EPROMS can be 2708 or 2716, normal cursor/inverted video can be selected, either normal or inverted video, and video level adjustments can be made.

•Language—I've used my card with everything currently available for the Apple. This includes DOS 3.3, Pascal, Fortran, and the Z-80 Softcard. No problems, except for clearing the screen, have been encountered. Videoterm is compatible with some of the word processors too. Check the WP documentation if you're not sure. As of this date, Super-Text is not one of the compatible WP's.

•Graphics—Apple's normal graphics are not possible with Videoterm. A simpler graphics capability is available though. There are simple graphics included in the character set. It is a block and partial block format callable with control codes. Listing 1 is a short program for displaying the graphics characters. The character set also includes line graphics for making document formats on the screen.

Documentation

A detailed manual is included with the system. There are the usual typos and editorial goofs but the information is very complete otherwise.

A program listing is provided to show you how to drive your printer and see the ouput on the screen at the same time. Otherwise, when you call a printer, you turn the video board off. One suggestion is made to use a TV with an RF modulator as an optional monitor. This is a good idea when you first turn the system on and the Videoterm is not on yet. Another way I have tried is to include the PR#3 in the disk boot program.

All Basic programs worked—more or less. On pages 4-18, line 40 was left out. The description on pages 4-19 mentioned it and this seemed to work:

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You depend on good software to save you time and to have your computer help you do a job more efficiently. Our software is designed to do just that. We are one of the oldest companies supplying software for the Apple II*, and one of the very few that offers an unconditional guarantee of satisfaction or your money back! Here are a few that you'll want to add to your library:

Super Terminal Software

ASCII EXPRESS II, by Bill Blue. The most complete communications package available for the Apple II. Designed for the most efficient transfer of data to or from practically **any** online computer. Fully supports upper/lower case, including characters normally unavailable: underscore, rubout, break, and most others. Keyboard **macros** allow you to define dual keystrokes as entire strings for fast sign-ons, sign-offs, and system commands. A 20K data buffer allows for large files, and a convenient line editor means easy editing before and after transfer. Buffer can be output to printer, disk, or viewed at any time. Supports Micromodem II* and most other communication devices.

Price: $64.95 on Disk

And for the Z80 Apple...

Z-TERM, by Bill Blue. A flexible communications package for the Apple II equipped with Z80 Softcard* and the CP/M* environment. Allows file transfers to or from all types of dial-in systems. Fully supports Micromodem II and most other communication devices, as well as 80 column display boards and external terminals! Utilizes standard CP/M sequential text files, with up to a 40K internal buffer (using additional RAM or Language Card.) Supports multiple modes of data transfer and includes keyboard **macros**, autodial (with Micromodem II), and upper/lower case.

Price: $99.95 on 16 sector diskette

Also available...

APPLE-DOC, by Roger Wagner. A set of several utilities to speed up software development and customization. **Vardoc** makes a list of all the variables in a program and every line on which they occur. Also allows you to create a list of descriptors of what each one does. **Linedoc** makes a similar list for each line/subroutine called by a GOTO, GOSUB, etc. **Condoc** is similar but documents all numeric constants — great for scientific & business uses! **Replace** is a powerful replacement editor which makes changing any occurance of a variable or group of statements a breeze!

Price: $34.95, Disk

THE CORRESPONDENT, by Roger Wagner. An extremely versatile program! Designed primarily for writing letters and other documents in a very visual way. The Apple screen acts as a "window" onto a 40-80 column page. 4-directional scrolling lets you see any part of the page just as it will be printed. Editor functions include full upper/lower case & control chars., block move/copy, split screen option, even math functions! Additional utilities & uses include printing form letters, a free-form database, putting bi-directional scrolling in your own programs, single-disk copy program, DOS remove for greater storage on diskettes, and more!

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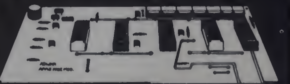

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GALAXY SPACE WAR 1

Galaxy Space War 1[1] (WAR1) is a game of strategy in which the player has complete control of his space fleet's tactical maneuvers. Each fleet battles its way toward the opponents galaxy in an attempt to destroy it and win the war. WAR1 simulates the actual environment encountered in a space war between two galaxies. Optimum use is made of Apple's high resolution graphics (HIRES) and colors in displaying the twinkling stars universe, the colored ships of each fleet, long range sensors colored illuminations, and the alternating blinking colors used in battles between ships. Complementing HIRES are the sounds of war produced by Apple's speaker.

WAR1 is played between Apple and a player or between two players. You may play with total knowledge of each others fleet or only ships sensor knowledge of the opponents fleet. Each player builds his starting fleet and adds to it during the game. This building process consists of creating the size and shape of each ship, positioning it, and then allocating the total amount of energy for each ship.

During a player's turn he may dynamically allocate his ships total energy between his screen/detection and attack/move partitions. The percentage of the total energy allocated to each partition determines its characteristics. The screen/detection partition determines how much energy is in a ship's screens and the detection sector range of its short range sensors. The attack/move determines the amount of energy the ship can attack with, its attack sector range, and the number of sectors it can move in normal or hyperspace.

STOCK MARKET ANALYSIS PROGRAM

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ANA1[2] (ANALYSIS 1) is a set of BASIC Programs which enables the user to perform analyses on the Dow Jones Industrial weekly average data. From 6 months to 5 years of user selected DJI data can be plotted on the entire screen in one of 5 colors using Apple's High Resolution capabilities. The DJI data can be transformed into different colored graphic representations called transforms. They are: user specified moving averages, a least squares linear fit (best straight line), filters for time, magnitude, or percentage changes, and user created relationship between the DJI data, a transform, or a constant using +,-,x,/ operators. Colored lines can be drawn between graphic points. Graphic data values or their dates of occurrence can be displayed in text on the screen. Any graph or text can be outputted to a users printer. The Grid Scale is automatically set to the range of the graphs or can be user changed. As many colored graphs as wanted can be plotted on the screen and cleared at any time. The user can code routines to operate on the DJI/transform data or create his own disk file data base. ANA1 commands can be used with his routines or data base. An update program allows the user to easily update a file with current data.

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1 Software Reviews: Apple Orchard (1?/80), The Book (1/81), Creative Computing (4/81)
2 Software Reviews: Call-A.P.P.L.E. (2/80), Apple Orchard (3/80), Info World (8/80), Creative Computing (5/81)

```
                 0900 * MULTIPLE SCREENS
                 0910 *
                 1000 * THIS PROGRAM WILL SHOW ALL OF THE
                 1010 * PAGES OF TEXT AND GRAPHICS
                 1020 * AT THE SAME TIME (IMPOSSIBLE
                 1030 * HUH?). ACTUALLY, THE VIDEO
                 1040 * MONITOR JUST CAN'T KEEP UP WITH
                 1050 * THE CHANGES AND SHOWS ALL THE
                 1060 * SCREENS. TYPE ANY KEY TO ROTATE
                 1070 * THE SCREEN.
                 1080 *
                 1090 * BY TOM SPIDELL
                 1100 * MILWAUKEE, WI
                 1110 *
0000-            1120 DUMMY      .EQ $00
C000-            1130 KEYBOARD   .EQ $C000
C050-            1140 GRMODE     .EQ $C050
C010-            1150 KEYCLEAR   .EQ $C010
C051-            1160 TXTMODE    .EQ $C051
C054-            1170 PG1        .EQ $C054
C055-            1180 PG2        .EQ $C055
C056-            1190 LORES      .EQ $C056
C057-            1200 HIRES      .EQ $C057
                 1210 *
                 1220 *-----------------------------
                 1230 *
                 1235            .OR $300
0300- AD 50 C0   1240 BEGIN     LDA GRMODE
0303- A1 00      1250           LDA (DUMMY,X) ;6 CLOCK CYCLES
0305- AD 56 C0   1260           LDA LORES
0308- A1 00      1270           LDA (DUMMY,X)
030A- AD 57 C0   1280           LDA HIRES
030D- A1 00      1290           LDA (DUMMY,X)
030F- AD 55 C0   1300           LDA PG2
0312- A1 00      1310           LDA (DUMMY,X)
0314- AD 51 C0   1320           LDA TXTMODE
0317- A1 00      1330           LDA (DUMMY,X)
0319- AD 54 C0   1340           LDA PG1
031C- B5 00      1350           LDA DUMMY,X ;4 CLOCK CYCLES
031E- AD 00 C0   1360           LDA KEYBOARD
0321- 10 DD      1370           BPL BEGIN
0323- AD 10 C0   1380           LDA KEYCLEAR
0326- 4C 00 03   1390           JMP BEGIN
                 1400           .EN

SYMBOL TABLE

0300- BEGIN
0000- DUMMY
C050- GRMODE
C057- HIRES
C000- KEYBOARD
C010- KEYCLEAR
C056- LORES
C054- PG1
C055- PG2
C051- TXTMODE
```

Listing 2. Program to display all the graphics pages.

```
100 HOME
110 FOR I=1 TO 15
120 PRINT CHR$(26)+CHR$(I);"  ";
130 NEXT I
140 PRINT:PRINT
150 FOR I=17 TO 30
160 PRINT CHR$(26)+CHR$(I);"  ";
170 NEXT I
180 END
```

Listing 1. Program to display the Videoterm graphics characters. Note that CHR$(26) is CONTROL Z.

40 COL = RND(2)

The program on pages 4-23 includes the HOME command at line 2. Won't work! Change it to PRINT CHR$(12) and then it will be OK. On pages 4-25 the description indicates that line 5 prints a CTRL-D. This should be CTRL-L. A discussion of PEEKs and POKEs on pages 4-3 indicates "these may not work quite as planned. However, these should work properly, as should your 'VTAB' and 'TAB' commands." I still haven't figured this out.

Conclusions

This board was my choice after checking out the attributes of several others. Using a board such as this is a much better choice than having a separate terminal. The cost is much lower too. Features that work with Apple Basics and not with the Z-80 Softcard Basic aren't problems for me. My interests are not in the area of graphics either. Overall, I'm very pleased with the capability of the Videx Videoterm 80-column board. The fact that I can't use it with my WP is not important either. Super-Text is a free-form entry system. Line length is controlled with the format line at print time. There is no need to "see" the line length during input. I'd recommend this card to anyone having a need for an 80-column display.

NEW BOOK

For those of you interested in Apple Machine Language, a new book has been published, *Apple Machine Language* by Don and Kurt Inman. The book is published by Reston Publishing Co. Inc., Reston, VA.

This book may be the best ever for the beginner. It is profusely illustrated with examples, drawings and diagrams. Twelve chapters lead you through a review of Applesoft, the similarities between Basic and machine language, and several exercises in machine language. You learn about simple graphics, displaying text, Apple sounds, the Apple system monitor, and doing mathematics in machine language. The use of the mini-assembler is thoroughly discussed and a final chapter tells you how to put it all together. Included in the appendix are sections on Basic statements, machine language instructions, built-in subroutines, hex to decimal negative equivalents, how video memory is mapped, ASCII screen codes, color codes for low resolution graphics, and a very nice presentation of the 6502 instruction codes. The one shortcoming I saw is that it requires the availability of Integer Basic. My copy cost $15 at one of the local computer stores.

THE ASSEMBLY LINE

Also for the assembly/machine language programmer, a new newsletter. From S-C Software, the source of an excellent Apple-oriented Assembler, comes a 6502 assembly language newsletter. The February 1981 issue lists several "Apple Noises and Other Sounds." These included: simple tone, Apple 'bell' subroutine, machine-gun noise, laser 'swoop' sound, inch-worm sounds, touch-tones simulator, and Morse code output.

Other topics include: "Stuffing Object Code in Protected Places," "Multiplying on the 6502" and "A String Swapper for Applesoft."

Previous issues have included programs for converting certain keyboard keys to a 10-key system for data entry. Listing 2 is the program for the 10-key capability. A portion of the newsletter is devoted to updates, patches and other items of interest to users of the S-C Assembler II. Reviews of the assembler were included in the July and December '80 issues of *Creative Computing*. You can get the newsletter by sending $12 for one year (12 issues) to Apple Assembly Line, S-C Software, P.O. Box 5537, Richardson, TX 75080. Other countries add $6 per year for extra postage.

```
                 1000 *--------------------------------
                 1010 *      NUMERIC KEY PAD FOR APPLE
                 1020 *--------------------------------
                 1030        .OR $300
                 1040        .TF B.NKP
                 1050 *--------------------------------
0300- A9 01      1060        LDA #1
0302- 8D 10 03   1070        STA TOGGLE
0305- A9 12      1080        LDA #NKP
0307- 85 38      1090        STA $38
0309- A9 03      1100        LDA /NKP
030B- 85 39      1110        STA $39
030D- 4C EA 03   1120        JMP $3EA
                 1130 *--------------------------------
0310-            1140 TOGGLE .BS 1
0311-            1150 SAVEY  .BS 1
                 1160 *--------------------------------
                 1170 NKP
0312- 20 1B FD   1180        JSR $FD1B
0315- C9 93      1190        CMP #$93     CONTROL-S
0317- F0 1D      1200        BEQ .4
0319- 2C 10 03   1210        BIT TOGGLE
031C- 30 10      1220        BMI .2       NOT IN NUMERIC MODE
031E- 8C 11 03   1230        STY SAVEY
0321- A0 0B      1240        LDY #TBLSIZ-1
0323- D9 41 03   1250 .1     CMP CHRTBL,Y
0326- F0 07      1260        BEQ .3       FOUND IN TABLE
0328- 88         1270        DEY
0329- 10 F8      1280        BPL .1
032B- AC 11 03   1290        LDY SAVEY
032E- 60         1300 .2     RTS
032F- B9 4D 03   1310 .3     LDA ALIAS,Y
0332- AC 11 03   1320        LDY SAVEY
0335- 60         1330        RTS
0336- AD 10 03   1340 .4     LDA TOGGLE
0339- 49 80      1350        EOR #$80
033B- 8D 10 03   1360        STA TOGGLE
033E- 4C 0C FD   1370        JMP $FD0C
                 1380 *--------------------------------
0341- AF CC A0
0344- CE CD AC
0347- C8 CA CB
034A- D9 D5 C9   1390 CHRTBL .AS -"/L NM,HJKYUI"
000C-            1400 TBLSIZ .EQ *-CHRTBL
034D- 8D         1410 ALIAS  .HS 8D
034E- AD B0 B1
0351- B2 B3 B4
0354- B5 B6 B7
0357- B8 B9      1420        .AS -"-0123456789"
                 1430 *--------------------------------
  SYMBOL TABLE

  034D- ALIAS
  0341- CHRTBL
  0312- NKP
  .01=0323, .02=032E, .03=032F, .04=0336
  0311- SAVEY
  000C- TBLSIZ
  0310- TOGGLE
```

Listing 3. Program from The Assembly Line showing how to use the Apple as a 10-key data entry keyboard.

READERS' INPUT

Continuing with more assembly language, here's a graphics routine by Tom Spidell from Milwaukee, WI. The program switches graphics pages and from one type of graphics to the other. The concepts included here can be used in your program to switch graphics pages. You can CALL the program from a basic routine as needed. Listing 3 shows the program using the syntax of the S-C Assembler II. Don't forget that a program located at address $0300 is activated by CALL 768.

One Liners

Listings 4 and 5 are graphics one liners from Bob Sander-Cederlof. One makes a quilt pattern and the other draws concentric patterns resembling the layers of an onion. Maybe that's why Bob calls it "Make an Onion." Both are high res graphics routines. Be sure to type them very carefully.

Does anyone else have one liners they would like to share? Send them to me and I will include them in the column.

```
100  REM
QUILT PATTERN
-------------
BOB SANDER-CEDERLOF
FEBRUARY 4, 1981
200  HGR2 : FOR A = 26 TO 156 STEP
     26: FOR C = A - 25 TO A: HCOLOR=
     A / 26: HPLOT 20,C TO 259,C:
     C = C + 1: FOR D = 20 TO 220
      STEP 40: HCOLOR= (D + 20) /
     40: HPLOT D,C TO D + 39,C: NEXT
     : NEXT : NEXT : FOR I = 1 TO
     5000: NEXT : TEXT : HOME : LIST
```

Listing 4. One-liner makes a quilt pattern in color.

```
100  REM MAKE AN ONION
110 CF = 1.15:XC = 140:YC = 96: HGR2
     : HCOLOR= 3: FOR N = 1 TO 48
     :R = 2 * N - 1:P = 6.2831853
     1 / N:C =  COS (P):S =  SIN
     (P):X = R:Y = 0: HPLOT XC +
     X * CF,YC: FOR I = 1 TO N:XN
      = X * C - Y * S:YN = X * S +
     Y * C:X = XN:Y = YN: HPLOT  TO
     XC + X * CF,Y + YC: NEXT : NEXT
     : FOR I = 1 TO 2000: NEXT : TEXT
     : END
120  REM BY BOB SANDER-CEDERLOF
```

Listing 5. One-liner draws onion-like concentric circles.

QUESTIONS 'N ANSWERS

About Random Numbers—In the January '81 issue, there is a program to generate random color blocks. The program on page 144 is part of the "How to Solve It—With the Computer" series by Donald T. Piele. Here's the program:

```
10 GR
20 COLOR = 9
30 X = INT(40*RND(1))
40 Y = INT(40*RND(1))
50 PLOT X,Y
60 GOTO 30
70 END
```

The expected result is for the program to fill the screen—eventually—with blocks of color. Usually, the program seems to stop with the screen only partially filled.

Checking around, I found this is an anomaly with the Applesoft random number generator. The number used to seed the random number sequence gets stuck and the range becomes limited. My understanding stops right here, but not my curiosity. The description of Applesoft page zero usage in the Applesoft manual indicates that memory locations $C9 to $CD hold the random number. By modifying the original program slightly, I found that I could get the screen to fill every time. And, there was no noticeable similarity to the pattern. A line is added to poke another random number into one of the locations where the random number is stored. In decimal, these are locations 201 to 204. Here's the new program line:

```
25 POKE 201,PEEK(INT(255*RND(1)))
```

Then change line 60 to read:

```
60 GOTO 25
```

Apple Cart, continued...

Line 25 is pulling a number randomly from page zero. These page zero values are often changing as the (any) program is running. Once this was done, the program never failed to fill the screen. If someone can provide an explanation, please do. Many readers and at least one columnist will be grateful.

About Assembly Language Indexing - Fundamentals of Indexing were described in the November '80 issue. Generally the information was well received but, there were a couple of questions. Here is some additional information to support the November '80 column.

First, some backup on operands and opcodes in assembly language. The operand is the key element used in the program to determine which of the opcodes will be used. Notice that absolute indexing uses the form $0900,X while indirect indexing uses the form ($3A),Y. These are only two of the indexing operands. Some others are ZP,X,ABS,Y, and (ZP,X) where ZP means Zero Page. Each one accomplishes indexing a slightly different way. And, each one will use a different operand in the machine language code (generated during the assembly of an assembly language program).

The opcode is used by the instruction set, the 6502 microcode, to define what is to happen next in the program. When the indexing opcode or instruction is executed by the microprocessor, it knows whether to look for a byte of data *at* an address or *for* a two byte address. That's why I used the statement that a two-address indirect location is implied. Since it takes two bytes to store a 16 bit address, the microcode program in the 6502 knows to look at two consecutive memory locations for the address of the table to be indexed.

Page zero addressing is implied in just the opposite way. The addresses are $0000 to $00FF. Because the first two bytes are always $00 the microcode interpretation of page zero instructions knows the first byte is always $00. Therefore, page zero instructions only need one byte—8 bits—to specify the usual 16-bit address. Since only one byte is needed, less code is used and the program will run faster because only half the page zero address must be decoded. (Notice too, that the low byte of the index table is stored in address $0300 and the high byte is stored in $0301. This is 6502 convention.)

In the May '80 issue of *Creative Computing* a discussion of Machine Language Fundamentals was included. Also, there are a couple of books that I recommend (In addition to the new one in this column). The books are:

6502 Software Design, Leo J. Scanlon, Sams # 2156. (Good book for beginners.)

6502 Assembly Language Programming, Lance Leventhal, Osborne/McGraw Hill. (Very detailed and complete.)

About Interpreters—For instructional purposes, I'm interested in Pascal and Fortran interpreters. I've looked for these in various ads but have not yet found one. Using a compiler for learning is painfully slow. For each little program segment the student is required to go through the entire compiling sequence to find out if the routine works. Compilers are definitely needed for large application programs and the student should know how to use them. But, during the initial instruction period getting familiar with the language would go much faster with an interpreter. It's sort of like learning to drive a car. It's a lot easier to teach the fundamentals of driving with a car equipped with an automatic transmission. A manual transmission creates too many distractions for the new driver.

Pascal or Fortran interpreters need not be fast. But they should be compatible with all the error message and functions of the compiled equivalent. If error messages could be generated with each typed line, all the better. A good example is the way Apple Integer Basic is handled. Each line is checked as it is typed in. This way, the student gets immediate feedback and doesn't have to wait for compile time or run time errors to find out what happened with the program. How about it, anyone want to become rich and famous? □

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Outpost: Atari

Paul Hoffman

The Atari computer is rapidly becoming one of the most popular home computers because of its advanced video capabilities. With the new business programs that are being released by Atari and third-party vendors, the neophyte computer enthusiast who wants a machine that can balance his checkbook and inventory his stock may now look more favorably at the Atari line than in the past.

No home computer has the range of sophisticated graphic capabilities that the Atari 400 and 800 have. There are no Star Raiders clones for the Apple or TRS-80 because those machines are simply unable to imitate the smooth player motion of the Atari. They are also unable to quickly mix text and graphics the way the Atari can.

One big difference between the Atari and the Apple or TRS-80 is the way information is put on the television screen; the Atari display list concept, although harder for a novice to use, is much more powerful and flexible than screen display methods used by other computers. The other important difference is Atari's player-missile (PM) graphics, which other computers lack.

Other Atari features that give it expanded graphic capabilities are its inexpensive graphic input devices (joysticks and the new light pen), and the easy use of color intensities for shading three dimensional pictures. Together with the assembler/editor cartridge, these features allow the user to create exciting visual displays and informative graphics.

Much of this column is "technical" in the sense that it refers to parts of memory not mentioned in the Basic manual, or to concepts in computer graphics that are beyond the scope of Atari Basic. This does not mean that beginners will not benefit from reading it; beginners can become advanced programmers quite rapidly. Also, if you're a novice programmer and have ever wondered how some of the nifty things that you see in the Atari games are done, read on—many will be explained shortly.

If one intends to do much machine language programming—especially graphics programming—on the Atari, knowing about the various hardware registers is essential. Unfortunately, the only manuals from Atari are poorly assembled, full of typographical mistakes, and expensive. Still, if the following discussion makes you want to delve further into the Atari, you should purchase the Operating System User's Manual and Hardware User's Manual. Together, they cost $30 (including shipping), and can be obtained from Atari, Attention: Barbara Burbridge, 1344 Bordeaux Dr., Sunnyvale, CA 94086.

In this column, bytes that are associated with hardware or screen manipulation are called registers, and are addressed in hex. The bits of a byte are referenced from the rightmost (lowest order) bit. Thus, "bit four" refers to the fourth bit from the right.

Paul Hoffman, 48 Norfolk St., Cambridge, MA 02139.

The Display List

Every microcomputer has a way of displaying objects and text on the screen of your television. The computer stores the information ("put these characters here," "make this area green") you have given it in memory, while memory-to-screen hardware reads the information and turns it into a signal for your television screen or monitor.

Apple and TRS-80 computers use bit-mapped graphics. The memory which the hardware reads to display the screen (screen memory) consists of a list of data. In the Apple's low-resolution mode, each pixel (dot on the screen) is described by four bits; a 0000 means that a black dot is to be displayed, 0111 a blue dot, etc. Thus, the memory-to-screen hardware does not need to do much analysis on the screen memory in order to convert it to a television signal pixel by pixel.

The Atari, on the other hand, does not keep this sort of map. It uses a display list, which can be thought of as a program for the memory-to-screen hardware to run to produce the signal for the television. The display list program includes commands to produce blank or solid color horizontal lines, change the graphics mode, start getting information from another part of memory, and type text on the screen.

The display list is not as easy to use as bit-mapped graphics, but it allows you to make much more complex screen images. It gives you the opportunity to use many graphics modes at once, and makes changing the screen a very fast process. Learning to use it to its fullest is not hard.

The display processing hardware is fast enough, relative to your ability to move memory around so that animation is easier to program with a display list than with bit-mapped graphics. Although some animation can be done from Basic (see below), using the display list and machine language gives great flexibility to the advanced graphics programmer.

Using Display Interrupts

Basic programs cannot move objects on the screen very rapidly due to the speed of program execution. Even player-missile graphics, Atari's super-fast system for displaying moving objects on the screen, seems slow when called from Basic. Clearly, assembly language programs run much faster than Basic programs, and there are some special techniques to make interactive graphic programs run smoothly. The technique used by Atari in

Figure 1.

```
        Player 0    Player 1    Player 2    Player 3
        12345678    12345678    12345678    12345678
   1       XX
   2       XX            X                     X
   3       XX           XX                     XX
   4       XX          XX       XXXXXXXX        XX
   5       XX         XX        XXXXXXXX         XX
   6       XX        XX                           XX
   7       XX       XX                             XX
   8       XX       X                               X
```

Figure 2. PORTA ($D300) Joystick reading

```
Bit   7      6     5    4       3      2     1    0
    Right  Left  Back  Fwd    Right  Left  Back  Fwd

          Jack 2                     Jack 1
```

their games to move objects gracefully on the screen is called display-list interrupt processing. (A special thank you to the programmers at the Bit Bucket in Newton, MA for much of the following discussion.)

A brief explanation of interrupts: an interrupt is a flag which gets checked every time a certain process is about to be executed. If the flag is on, the process is not executed, and the program jumps to another area of the program (called the interrupt code). When the interrupt code has a return instruction saying that it is finished, the program then starts the process from which it was interrupted.

Some interrupts are checked each time the machine performs an instruction, while others are checked during pauses in machine operations. The display list can be interrupted at two levels: while the electron beam is returning from the bottom of the screen to the top, or while the beam is returning from the right of the screen and moving down one line. The first is called a vertical blank interrupt, the second a line interrupt.

The television screen is filled every sixtieth of a second; since the Atari uses 248 of the 262 screen lines, you have about 8.4% of one sixtieth of a second to perform operations on the screen. This is about 1400 microseconds, of which about 10% is taken by the CPU for memory refresh. You have enough time to perform around 500 assembly commands (1.8 cycles per microsecond, with an average of 4.5 cycles per command).

If the interrupt routine keeps the interrupt flag turned on, then the routine will execute, display the screen, and loop until the flag is turned off. This is sometimes useful if you can write most of the code necessary to run your program within the constraints of the interrupt routine. To return to your controlling program, all you have to do is turn the interrupt off. The controlling program runs while the screen is displayed and the interrupt routine is executing.

A typical graphics-oriented Basic game program would set up the game board, initialize the score counters, poke the interrupt code into memory and turn on the vertical blank interrupt. It would only return to the Basic program for score keeping, or to change the playing field if it were a multi-board game. The interrupt code would be responsible for reading the joysticks, moving the players, and determining whether an important event had happened.

Player-Missile Graphics

The feature which allows the Atari to do the most advanced video displays is Player-Missile (PM) graphics. Much of what is known about the use of the PM subsystem has been explained in this column in previous issues. Two aspects of PM that have not been covered are collision detection and animation.

You will need some familiarity with the PM subsystem to understand fully the following section, although you can get most of what you need to know from this column in the January 1981 issue of *Creative Computing*. There is so much that can be done with PM that no article can pretend to cover it all, since combining PM and other Atari-specific features can yield wonderful new results.

Once you have the players and missiles moving around the screen, especially in a game situation, it is useful to know when a player hits another player, or hits a missile, or even when it (or a missile) moves to a part of the playfield that is a certain color.

To see if two PM objects have hit, Atari has provided the collision registers. Every sixtieth of a second, the Atari determines all current collisions, and turns the appropriate bits on in the collision registers described below. The collision registers are cleared by writing anything into the HITCLR register ($D1OE), and have data only in the lowest four bits of each byte.

Registers M0PF, M1PF, M2PF and M3PF ($D000-$D003) describe the missile-to-playfield collisions, and P0PF, P1PF, P2PF and P3PF ($4D004-$D007) describe the player-to-playfield collisions. The lowest order bit of $D004 being on means that player 0 hit playfield 0 (an object written in color 1, SETCOLOR register 0), the next higher bit means it hit playfield 1, and so on.

Registers M0PL, M1PL, M2PL and M3PL ($D008-$D00B) detect collisions between players and missiles; registers P0PL, P1PL, P2PL and P3PL ($D00C-$D00F) detect collisions between two players. Missile 2 hitting Player 3 would be shown by the third lowest bit of $D00A being set to 1. Similarly, Players 0 and 1 hitting each other would be indicated by bit 0 of $D00D and bit 1 OF $D00C being set.

The Atari's PM subsystem can also be used for limited animation. This is done by setting up the four players as pictures, and having only one visible at a time. This is done by having players 1, 2, and 3 set to the background color for an instant, with player 0 set to a different color, then 0, 2 and 3 being background with 1 a different color, and so on. If you change the horizontal position registers as you switch color, you can simulate movement. Figure 1 shows how to draw the four players to animate a board rolling end over end from left to right.

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In 1976, Creative published *The Best of Creative Computing, Volume 1*. I proposed to Virginia Londoner, publisher of *Byte*, that we also publish articles from *Byte* in book form. She agreed, and so we published *The Best of Byte, Volume 1*. It's a huge book of 386 pages with articles on hardware, software, technical tutorials, how-to materials and even some philosophy.

Although some of the technical material in *The Best of Byte* is out of date today, it nevertheless provides a good historical framework for the personal computing field. Not at all out of date are most of the software articles and tutorials. Similar books of other publishers are selling for $20 and up, so at $11.95, this one is quite a bargain.

Big Hearted

About the same time we were preparing *The Best of Byte* for publication, Nat Wadsworth of Scelbi approached Byte about doing a similar book. Virginia wanted to be nice to everyone, so she gave permission. Thus was born the *Scelbi-Byte Primer*.

Unfortunately, about half of the content of the two books was identical. Thus *Byte* was faced with a dilemma of which book to endorse and sell through their magazine. Inexplicably, they chose the Scelbi book. Thus we were left with twelve skids of *The Best of Byte*.

Hidden Away

In the next three years we sold a lot of these books. In fact, after we ran a special in 1979, we thought we had sold out.

However, we just moved to new quarters. In the move we found, lurking away in the back of our old garage, four skids of *The Best of Byte*. After some fitting words, the boss said "for 2¢, I'd give them away." So that's what we're doing.

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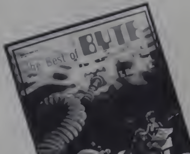

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Outpost, continued...

Fast Joystick Input

In its Assembler/Editor manual, Atari recommends that I/O be done through your Basic program, and that assembly language should be only used "when its speed advantages outweigh the difficulties of programming in assembly language." This is overly cautious for advanced programmers, especially in terms of joystick input.

The main advantage of including your joystick-reading routines in the machine language subroutines that you are using in your Basic programs is increased accuracy of response. There are many Basic routines for reading the joystick and testing whether it is straight up, or determining the X and Y directions. An assembly language program to return the same information is much faster than any Basic subroutine, and can be done up to sixty times a second (the rate at which the port information is updated).

The ports on the front of the Atari are controlled and read by hardware registers. Jacks 1 and 2 are considered Port A, and jacks 3 and 4 are Port B. To read a joystick in jack 1, the port A control (called PACTL, $D302) must have the third bit set on. The status of the joystick is read in the four low order bits of byte PORTA, which is $D300 (see Figure 2). A bit set to zero means that the switch in a particular direction is pressed. The values for the directions correspond to those returned to Basic by the STICK(n) call.

Port B is controlled by PBCTL ($D303), with jacks 3 and 4 being read from PORTB ($D301), similar to port A. The joystick triggers for both ports are read in the lowest bit, or $D010 through $D013, with a zero indicating that the button is pressed.

Other Interactive Input

Using joysticks for positional input is not hard, although there are other exciting ways to give the Atari the coordinates of a desired location on the screen. While joysticks are good for giving directions ("move me up and to the left"), you often only want to point to a specific position on the screen ("move me to here.") Two new input devices are now available: the light pen and the graphics tablet.

A light pen does not give off light; it reads the light from your television screen. You touch the light pen to the screen to indicate a desired set of screen coordinates. The Atari light pen figures out where you are pointing by watching the electron beam of the television and calculating how long it was since the beam was at the top left of the screen. The pen is polled every sixtieth of a second.

The position of the light pen is read from hardware registers PENH ($D40C) and PENV ($D40D). The first byte is the horizontal position, ranging from 0 to 227; the second byte is the vertical position, ranging from 0 to 130. You can determine the screen coordinates of the point by figuring out the range of the screen compared to the range of values for PENH and PENV.

Another very useful input device is a graphics tablet. Many are now available for the Atari. A graphics tablet is a tabletop device, usually around 18" x 18", and flat. By touching the special pen to the surface of the tablet, you receive a pair of XY coordinates, as with the light pen.

The big advantage of the tablet over the light pen is that you can lay a piece of paper on the tablet and trace images or take data from it. Some applications include accurate drawing (no more messy joystick pictures), tracing pre-drawn pictures as input to programs, and getting responses from questionnaires quickly and accurately. Many of the tablets come with extensive software packages to make using them even easier.

Shading

If you own another home computer, or have shared programs with friends who do, you may have seen that the other machines do not have the ability to shade pictures. The Atari, with its intensity-selection capability, allows you to draw three dimensional objects with greater realism by using shading.

Using a computer to shade curved surfaces is complex, but it is certainly possible. For a very complete discussion of shading to achieve realism in computer drawings, you should read *Principals of Interactive Computer Graphics* by William Newman and Robert Sproull (McGraw-Hill). This book is an excellent reference for most topics in computer graphics, although it mostly deals with larger computers.

Other uses for the intensity control are in computer animation (for explosive colors, twinkling stars, etc.) and highlighting text without using inverse video characters. The Atari offers much in the way of precise choice of color for graphics applications.

Other Graphics Capabilities

Many graphics features you see in Atari games are simple extensions of the features listed above. For instance, to make game setup more interesting, you can set all the color registers to the background color, set up any necessary initial graphics, and reset the registers to their proper colors at the last instant (PM color registers can be used this way as well).

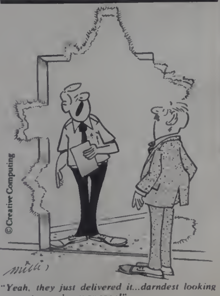
The limitation on the number of colors on the screen at any given time can be quite frustrating, but there are ways around it. The most simple is to use the PM subsystem to draw background, gameboards, or other features. A triple-width player and its associated missile can take up a fair amount of the screen if necessary. Using PM adds four new colors.

Also, the four missiles can be used to draw vertical lines on the screen. A little-known feature is that you can set the width of the missiles to single, double or triple width using register SIZEM ($D00C). The lowest two bits are for missile 0, the next two for missile 1 and so on. Set the bits to 00 for normal width, 01 for double width and 11 for triple width vertical lines.

Using line interrupts, you can change the color register for a particular player while it it being drawn. Thus, you can have multi-colored players. Or, using a single line interrupt halfway down the screen, you can change a single color register back and forth so that objects change colors as they move from the top of the screen to the bottom. It is unfortunate that line interrupts have virtually no documentation in Atari's manuals.

Conclusion

There are many more graphics capabilities of the Atari computers than can be listed here, and many are undocumented. The Operating System User's Manual and Hardware Manual, although sketchy in some areas, is helpful for many applications. Very little of the third-party software that is currently available has the extensive use of Atari-specific graphics that Atari's games have; as better documentation becomes available, this may change. □



"Yeah, they just delivered it...darndest looking computer you've ever seen!"

Software Legal Forum

The comments and opinions of the author are given for educational purposes only and are not meant to be legal advice. Specific legal questions should be referred to your personal attorney.

Harold Novick

As promised, the "Software Legal Forum" returns to the discussion of the legal rights of the software user (vendee in legalese). As a quick review of the April, 1981 "Forum," the legal rights of the software user depend upon whether the user is a "consumer" and whether the software is considered to be a service or a product. The preferred position for a software user is to be a consumer of a product.

Imagine the situation where a customer sees an advertisement in *Creative Computing* magazine for a new disk operating program called CP-UNEXT. This program is advertised as being compatible with all programs currently using the CP/M operating program. The program costs only $500 and comes on one diskette. Full documentation is alluded to in the advertisment, but not promised. The program is ordered and received without full documentation. Not to be deterred, the purchaser studies the incomplete documentation and decides to try to run it. Unknown to the purchaser and the seller, the program has a fatal error. If the incomplete documentation is followed literally, the program would cause the user to activate the fatal error. To make a long sad story short, just suppose that the running of the program causes all disks to be reformated in a destructive, contagious way. All diskettes used with the new operating system or with a diskette that had been used with the operating system would destroy all data files contained on the diskette. What can the unsuspecting purchaser do when all of his valuable data bases and records are wiped out? That is, besides cry?

The purchaser, who shall henceforth be named M. Pathos Purchaser, can certainly write the company and demand the $500 back. M. can also demand to be compensated for the lost records. M. can also demand payment for all of the contaminated diskettes and can demand reimbursement for the software expert who was hired to find the cause of the problem. In fact, M. Pathos can demand anything, even the moon. The question is: "What can he or she get?"

If the answer were simple, then there would not be any need for a computer lawyer or—perish the thought—for the "Forum."

There are many approaches that can be used to evaluate the hypothetical (?) fact situation. The one that this author has found to be most helpful is from a damages point of view. If one suffers no damages, then it may not be worthwhile to litigate. In fact in negligence tort law (civil wrongs done by one person to another, such as an automobile accident), one of the required elements is a compensable injury. Without such an injury, one cannot even sue. Another reason that this approach is instructive is that it permits a practical, objective (translate as "monetary") evaluation of the case. In most cases, the winner of a law suit cannot be reimbursed for the attorney's fees. Usually both sides must pay for their own lawyers.

In the present case, no fraud or deceit is present. Not only cannot M. Pathos recover his attorney's fees, he cannot recover punitive damages. In some egregious circumstances (e.g. mail fraud or fraudulent advertising), the plaintiff (i.e the "sue-or") with as little as $1 actual damages can recover thousands of dollars in exemplary damages to punish the law-breaking defendant (i.e. the "sue-ee").

In the present example, the software seller essentially made a contractual offer in the advertisement. The contract was made and legally enforceable when M. Pathos Purchaser accepted the offer by sending in an amount of money equal to the advertised purchase price. Thus, whether and how much M. Pathos can recover is determined by contract law.

There are three major ways contract law is made. All of the states have a statutory contract law and a court-made or common law contract law. In addition, the Federal government has passed some consumer legislation that affects contract law.

In the case of M. Pathos Purchaser, the applicable contract law depends upon whether the software was considered a product or a service. If it is a product, then there are certain guarantees that the seller makes irrespective of whether they were explicitly stated in the advertisement. If software is a service, then most likely the only guarantees are those contained in the advertisement. These guarantees, the legal terminology for which is "warranties," will be discussed in a subsequent column.

In addition to the software being a product, if Purchaser is a consumer, the Federal laws may apply. These laws relate to the warranties and the disclosure information that must be given. Under some state laws, if the purchaser is a consumer, the seller of the product cannot disclaim certain implied warranties. A "disclaimer" is a legal statement made by the seller in the contract for sale that the seller is not liable for any breaches of the disclaimed warranties. Thus, the affected states are saying that no matter what the seller says, the seller is still going to be responsible for failure to live up to certain guarantees that are inherently made when the product is sold.

For the present discussion, it will be assumed that the advertisement did not disclaim any warranties. It will also be assumed that the sold software is a product because the seller was not specifically hired by the purchaser to write the software and that the software was sold as an "off the shelf" item.

So what damages can M. Pathos Pur-

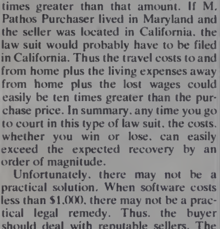
Harold Novick, Patent Attorney, Larson & Taylor, Arlington, VA 22202.

chaser collect? A refund of the purchase price ($500) would probably be awarded to him by a judge after a full trial. Also, the postage costs to buy the software would probably be awarded by the judge. However, it is doubtful whether M. Pathos could collect the money paid to the software consultant. Furthermore, there is some doubt whether M. Pathos could collect for all of the diskettes that were affected. If the diskettes were unusable, then the seller may be liable to Purchaser for the cost of empty diskettes. However, because the seller did not have notice of the data files, the seller may not be liable for the replacement cost of the data files.

All of the foregoing has completely bypassed the most pertinent considerations. In the example, a reasonably expected recovery would be close to the purchase price of $500. The lawyers' fees for going to court could easily be ten times greater than that amount. If M. Pathos Purchaser lived in Maryland and the seller was located in California, the law suit would probably have to be filed in California. Thus the travel costs to and from home plus the living expenses away from home plus the lost wages could easily be ten times greater than the purchase price. In summary, any time you go to court in this type of law suit, the costs, whether you win or lose, can easily exceed the expected recovery by an order of magnitude.

Unfortunately, there may not be a practical solution. When software costs less than $1,000, there may not be a practical legal remedy. Thus, the buyer should deal with reputable sellers. The buyer should also try to deal with someone close to home in case there are problems. Finally, the buyer should not be the first one on the block to buy the software unless he or she is willing to take the risk.

In conclusion, be a consumer, buy a product, and have good hunting. □



"I found the trouble with number three computer."

puzzles & problems

It's Contest Time!

That's right folks, it's CONTEST TIME!!! Merlin has decided that he wants to hold an Annual Summer Puzzle Contest (maybe a Winter one too). He said "Let's keep the rules simple. We'll give out ten prizes for the ten best puzzles sent into us. There will be no specific categories. Our readers can send in coin puzzles, change-the-word puzzles, logic puzzles, word-doodles, picture puzzles, I don't care so long as they are good puzzles."

"Who's going to judge the entries?" I asked backing towards the door.

"You are!" replied the wise one. "Along with Ector Pendragon, and myself if you need any technical advice."

"By what date do the puzzle entries have to be in by?"

"All puzzles must be postmarked no later than July 31, 1981," said Merlin. "I'll bet you'll never guess what I'm giving away as a prize to the ten winners?"

"Knowing you I have a pretty good idea, but I'll ask anyway, what marvellous prizes do you intend to bestow upon the winners?"

"I'm glad you asked!" smiled Merlin. "Each winner will get an autographed copy of *Merlin's Puzzler, Merlin's Puzzler 2, Merlin's Puzzler 3, The Clue Club,* which is a cartoon puzzle book that you wrote with my help, and last, but not least, *Computer Coin Games* by Joe Weisbecker. Just think of it, five great books for each winning puzzle!"

Well, that's the contest, readers. If you want to win enough puzzle literature to last you a year put on your thinking caps and write us a puzzle. Remember, the closing date for entries, is July 31, 1981. Good luck!

A Marbleous Puzzle

Our first problem is from Richard J. Hofmann, of Oxford, Ohio. This puzzle usually calls for wine and water, but, I think Mr. Hofmann's version is clearer. A copy of *Merlin's Puzzler* goes to you, sir!

A young boy has two containers of marbles in front of him, a white and a black container. The white container, on the left, has 100 white marbles and the black container, on the right, has 100 black marbles. The boy reaches into the container of white marbles and takes out 10 white marbles. He then places the 10 white marbles into the container of 100 black marbles and proceeds to mix them with the black marbles. Next he closes his eyes, reaches into the container of 110 black and white marbles, and removes 10 marbles. He places these 10 marbles into the container of 90 white marbles. Both containers now contain 100 marbles. Are there more black marbles in the white marble container than there are white marbles in the black marble container, fewer black marbles in the white marble container than white marbles in the black marble container, or is the number of black marbles in the white container equal to the number of white marbles in the black container?"

Sinbad's Hat

Here's an easy (?) puzzle from Mr. A.Q. Lippert of Dobbs Ferry, New York. Mr. Lippert writes: "Sinbad the Sailor starts rowing upstream. He travels one mile whereupon his hat falls off into the water and starts floating downstream. He continues upstream for 10 more minutes and then turns around and starts rowing back downstream. He catches up with his hat just as the hat reaches his original starting point. Sinbad's rowing speed is constant whether rowing upstream or downstream. How fast is the stream flowing?"

A copy of *Merlin's Puzzler 2* is flowing Mr. Lippert's way.

It's Riddle Time

1. Write the number 20 using four 9's.
2. When is it that 8 plus 6 equals 2?
3. Why is the letter *D* like a bad boy?
4. Why does an Indian wear feathers in his hair?
5. Why is a caterpillar like a hot biscuit?
6. What table has no legs?
7. Where can you always find happiness?
8. How many peas go into one pot?

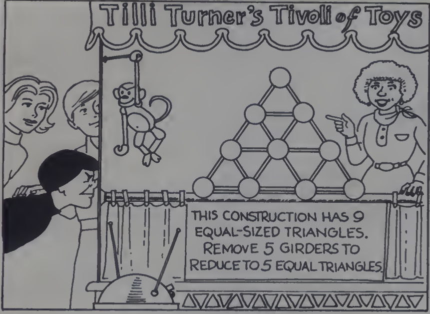
Two for the Show

From Mr. Rick Powers, of Dekalb, Illinois, we have two interesting puzzles. Don't peek at the answers now. I give you five minutes to solve them both. Congratulations, Mr. Powers, you've won a copy of *Merlin's Puzzler 3.*

Each of the following quasi-mathematical expressions encodes a grammatically complete English sentence:

Puzzle 1: 10 20 04 18 0

Puzzle 2: $\frac{\text{stand}}{\text{I}}$ $\frac{\text{take}}{\text{you}}$ $\frac{\text{mine}}{\text{2}}$ $\frac{\text{standing.}}{\text{my}}$



The Clue Club

For those of you out there in Puzzleland who have never heard of The Clue Club (which I mentioned in the contest prizes above) we have here a panel from this cartoon puzzle book. In The Clue Club you will learn how Mike Miller got his "super powers." How he built his robot computer "PAL," and how Mike won the famous puzzle contest held yearly in the town of Coltrane, the Puzzle Capitol of the World. You will also meet Roderick Sneakwell, a cheating puzzler if there ever was one; Calvin Barnstable who constructs "puzzle kites"; Blundar the Magician; Herr Rumplemeyer and "The Seldom Seen But Always Heard" Rock Band; Ms. Cindy Cindy, proprietor of The Volcano Record Shop, and many other interesting characters. (The Clue Club was written by Charles Barry Townsend & Dwight Dobbins, and is published by Bantam Books.)

The Fork in the Road

Merlin was journeying to London town. He passed through a community where every jolly inhabitant was either absolutely honest and never told a lie or absolutely dishonest and never told the truth. But lo, a fork in the road appeareth. And he knoweth not which fork to take. But lo again. A fair damsel comes skipping along and Merlin asks her one brief question. She gives one brief answer. And Merlin proceeds on his way to London town. What query did Merlin use?"

This is an entertaining type of puzzle which we have had before. It comes to us from a frequent contributor, R.O. Whitaker, of Indianapolis, Indiana. Merlin will be glad to "fork over" a copy of *Merlin's Puzzler* for this quaint puzzle.

Answers on page 224.

Many Into One

From the archives of the National Puzzle Museum on the Isole of Merlin comes this problem in geometry. You are required to rearrange the five triangular pieces of cardboard pictured here into a perfect square. One of the pieces may be cut in two. (This puzzle is from *Merlin's Puzzler.*)

Announcing a Major Media Event

During lunch the other day, MERLIN mentioned to me that he was thinking of publishing a magazine devoted to puzzles, and games, and a whole range of other exciting activities that he knows so much about.

"I want to put out a magazine that will be of interest to old and young alike," he said. "Do you think that enough of our readers would be interested in such a magazine to make it a success?"

"The only way to find out is to ask them!" I replied, which is what the coupon at the right is all about. If you love puzzles and games and riddles and quizzes and word puzzles and magic and stunts and contests and a hundred-and-one other activities then *let MERLIN know about it.* Just fill out the coupon and send it in. This is your chance to help start a great magazine. And, it will be your magazine too, because, right from the start you will help decide what kind of material will go into it. So, give the old boy your backing. He *needs to know* that *you* are interested in this magazine. Five minutes of your time today can give you a terrific magazine tomorrow. A magazine that only MERLIN, with his 1400 years of experience, could create!

Your editor,

Charles Barry Townsend

*** WE NEED TO HEAR FROM YOU!!! ***

Mail to:
Charles Barry Townsend
32 Hickory Drive
Maplewood, New Jersey 07040

Name ______________________

Street ______________________

City ____________ State ____________ Zip ____________

Age ________ Occupation ______________________

Would you like to see MERLIN publish a magazine devoted to puzzles, games, and other entertaining activities? .... Yes ☐

Would you subscribe to such a magazine? .... Yes ☐

What kind of subjects and articles would you like to have in a magazine of this kind? (puzzles, games, quizzes, crosswords, etc.)

1. ______________________
2. ______________________

book

Steve Gray

Pascal, by Paul M. Chirlian. Matrix Publishers Inc., Portland, OR. 219 pages, paperback $12.95. 1980.
Introduction to Pascal, by Neill Graham. West Publishing Co., St. Paul, MN. 253 pages, paperback $11.95. 1980.

The Chirlian book is an introductory book "intended for students who have had essentially no experience with computer programming or computers. It can be used by college or junior college students, or by those who are interested in teaching Pascal to themselves," according to the preface.

The 11 chapters include an introduction, Fundamental Arithmetic Operations, Input and Output, control statements, Arrays, Characters and Strings, subprograms, files, Sets, The RECORD and Variant, and Dynamic Data Structures.

Each chapter ends with two dozen or more well-chosen exercises, most of them requiring a program to be written or modified. Four appendices cover Pascal keywords, library functions, structure types, and operators.

The book starts slow and easy with a nine-line program on page 8 that adds two numbers and prints the results, with a two-page explanation. The chapter then expands this program. Most of the programs in the book are at most 15 or 20 lines long, most with enough text in the output printing to help figure them out.

Two blank flowcharts are shown, with the remark that "At one time they were widely used to represent algorithms and programs, but most programmers now feel that they are not too useful," and none are used.

The book contains two dozen "syntax diagrams," which are "used to represent the syntax, or structure, of Pascal."

The programs are all written in sans-serif boldface, with very few output results shown. The text is written in a semi-conversational style, and might have been improved with some real print-outs of programs, and with sample runs.

The Graham book is "suitable for either an introductory course in Pascal or an introduction-to-programming course using Pascal. No previous programming experience on the part of the students is assumed," as the preface puts it.

The 13 chapters are on Computers, Programs and Programming Languages; Pascal: First Steps; Using Main Memory; More About Expressions; Repetition; Selection; Functions and Procedures; Simple Data Types; arrays; Searching and Sorting; records; files; sets.

Each chapter ends with five or six exercises, most requiring programs to be written. Three appendices cover reserved words, the GOTO statement, and declarations assumed in text. Seven books are listed in a page of Further Reading.

The book starts out much more slowly than the Chirlian text, with more examples, and doesn't present an example program until page 39.

The programs are all enhanced by the use of boldface and italic printing, plus even more elaborate indenting than in the Chirlian book. Programs are explained in great detail before being presented—one of the several features that make Graham's book of greater value than Chirlian's to the reader teaching himself Pascal, and also to the classroom teacher, who is thus largely spared having to explain how this or that program works.

reviews...

Also, although the Graham book contains no diagrams of any kind, the text looks more "friendly," due to the choice of paper, typeface, wider margins, and more white space. Given a choice, most solo readers would probably take Graham.

Basic Fortran, by James S. Coan. Hayden Book Company, Rochelle Park, NJ. 245 pages, paperback $8.95. 1980.
Beginning Fortran, by Joe W. McKinley. Matrix Publishers, Portland OR. 251 pages, paperback $9.95. 1980.
Fundamentals of Fortran Programming, by Robert C. Nickerson. Winthrop Publishers, Cambridge, MA. 460 pages, paperback $11.95. Second edition, 1980.
Programming in Fortran, by William F. Schallert and Carol Reedy Clark. Addison-Wesley Publishing Co., Reading, MA. 447 pages, paperback $13.95. 1979.

Coan wrote one of the early books on Basic, and his Fortran book is in an easy-going, conversational style that is an improvement over the somewhat prosaic writing in his earlier book.

The first five chapters introduce features of Fortran: introduction, Writing a Fortran Program, Loops and Linear Arrays, Functions and Subroutines in Fortran, Miscellaneous Fortran Features and Techniques.

The remaining six chapters emphasize applications covering pre-calculus topics, with all required algorithms developed in the text: Elementary Data Processing, Miscellaneous Applications, Quadratic Function and Graphing, Trigonometry, Polynomials, Elementary Probability and Random Simulation.

Problems are provided after each section in each chapter. Four appendices provide a table of Fortran-supplied functions, an index of the 80 programs in the text, a Z80 random-number-generating function, and answers to the even-number problems.

This is an excellent book for the novice programmer, starting with a very simple program, building up slowly, providing runs for each program, and providing meaningful, well-chosen problems.

The 80 programs in the text range from printing polar coordinates to finding the largest element in an array, from searching for Pythagorean triples to demonstrating implied DOs.

McKinley's book is batch-oriented, full of photos of punched cards, and may thus be somewhat disconcerting to interactive or timeshare users, although the author claims such people "will find the book extremely useful in conjunction with the local rules for operating their system." Hmmm.

Intended for high school and college students "who are beginning to learn the language of Fortran," the book is in four sections. Section I, Beginning Programming, includes chapters on an Introduction; An Overview; Arithmetic Operations, Input/Output.

Section II, Intermediate Programming, has chapters on Control Statements, Subscripted Variables, Subprograms: Functions and Subroutines. Section III, Advanced programming, consists of one chapter, Some of the Fancier Tricks, such as Advanced COMMON and EQUIVALENCE. Most chapters end with problems and programming assignments.

Section IV, Computer Example Projects, provides 16 projects as "examples in the specific areas of interest which the specific learner wishes to pursue" and "in some instances, in some projects, advanced examples of programming are given." They range from roots of a polynomial to lift from wind-tunnel data, and take up all of 70 pages.

The book ends with a list of 24 references for further study, five appendices that are brief tutorials on keypunching, flowcharting, deck setups, matrix algebra, and what's in the IBM 1130 Scientific Subroutine Package, and answers to selected problems.

The writing is fairly good, and the author uses many diagrams with callouts and other graphic devices to help explain subroutines, data flow, etc.

The book begins with an overview showing just how a brief program is written, punched, and processed, with enough complex detail, such as a diagram of the "compilation of the Fortran program $FORTRAN to $FINIS" on page 12, that will floor some readers unless they have a teacher to explain what this chapter is all about.

Nickerson's second edition "presents changes in the Fortran language, updating the text to include ANS Fortran77 and some aspects of WATFIV-S in additon to the 1966 version of Fortran," according to the back cover.

This is a more formal book than the first two, with large blocks of solid text and a straightforward, mainly non-conversational writing style. Many examples are given, but few runs, and flowcharting is covered only in an appendix.

The 13 chapters provide introduction, I/O programming, arithmetic, decision, repetition, nonnumeric I/O, program development, data types, arrays, subprograms, and internal data representation. The first two chapters and the last end with review questions and computer exercises, the other with a dozen or more lengthy programming problems.

The book ends with five appendices, on Fortran Version Differences, Fortran-Supplied Functions, Keypunch Operations, Exponential Form and Input/Output, and Flowcharting.

Although this book isn't as "interesting" looking as the others, it's the one I'd choose for learning about Fortran, mainly because it teaches more about the basics of Fortran than the other three. Then I'd read Coan for additional material.

The fourth book, by Schallert and Clark, is written in a curious style, looking partly like a cram book, and partly as though written by a computer. Each of the chapters opens with a set of objectives, most of which resemble the type of questions found on examinations in Computer Science 101.

The first objective is "state the functions performed by a computer and identify the six features that enable a computer to perform them." Each of the objectives is repeated in the chapter, and is followed by material intended to provide an answer to the question.

This textbook is also batch-oriented, and tells exactly how to prepare cards on a keypunch. About half the book consists of examples and exercises; many of the latter provide space for writing routines on the page.

The book has 15 chapters: Computers and Programming; Fortran Language and Processing; Variables and Expressions; Statements, Subprograms and Control; Input; Output; Errors; Arrays I; Arrays II; Branching; Extended Control; Function Subprograms; Subroutines and Statement Subprograms; Subroutines; Project Programming.

That last chapter asks you to "design a complex program requiring a number of subprograms," in this case to compute the trajectory of a model rocket.

Each objective section within a chapter ends with exercises; each chapter ends with seven or eight pages of exercises and programming problems. The book ends with answers to the exercises.

Four appendices are provided: Keypunching, Statement Summary, Topics (punched cards, EBCDIC), Sorting, Round-Off Errors.

A unique feature is the boxed Programming Tips that "occur throughout the text and emphasize unique features of problem areas of which students should be aware." The student, for example, has to cross out the words that don't apply in phrases such as "My computer does/does not have the format-free statement."

The writing style is somewhat stiff and almost entirely non-conversational, and the pages are all very "busy," covered with boxes, little drawings, programming examples, etc. Despite all this, much good material is presented to those willing to wade through the clutter.

Social Issues In Computing, by C.C. Gotlieb and A. Borodin. Academic Press, New York, NY 284 pages. $16.95. 1973.

In this age of mushrooming computer technology, most computer scientists busily pursue the technical aspects of computing. The vast knowledge in our field overwhelms us. We strive to stay abreast of microprocessors, artificial intelligence, and database systems, to mention a few of the numerous specialties. While we diligently work at developing new systems and educating ourselves in the latest techniques, little time is left for questioning the social impacts of our efforts. In *Social Issues In Computing*, Gotlieb and Borodin review the impact of computers in present and future society and address the social responsibility of computer scientists and data processors.

Given the power that is conferred upon those who possess and control information and knowledge in today's society, the long-term social issues dwarf the technical issues which have preoccupied us so far. Although computer technocrats may better understand the force of the issues, this book will benefit anyone involved in information processing from the beginning student writing a sequential file processing program, to the government bureaucrat supervising the data banks of the Internal Revenue Service.

The book explores the better-known of the critical social issues—individual privacy and displaced labor. These are often described in the popular literature, however, this book presents a rigorous discussion of the issues and the thorough bibliography at the end of each chapter documents many sources for further research.

The chapter "Professionalization and Responsibility," presents the most provocative issues. We programmers marvel at the efficiency of our sorting algorithms and numerical methods, but are we responsible for the subsequent destruction if we implement these algorithms in software that guides nuclear missiles to a crowded metropolis? We do have a social responsibility which the authors poignantly stress.

For those who dream about the world of the next few centuries, the authors stimulate the imagination in the chapter, "Values, Technology, and Computers." This final chapter of the book discusses such philosophical issues as the meaning of leisure and the purpose of human existence. Consider life in the future. If computers completely care for humans and eliminate the need to work, what is the purpose of life? "Can activity other than work provide a truly human existence?" This chapter leads the reader into the realm of future automation, in which superhuman machines service our every desire and want.

Every computing practitioner should put aside the technical manuals for a short while in order to read this text. Dump the most suitable language problem, the garbage collection dilemma, and the deadly embrace nightmare to external storage! Refresh your "memory" with this book and "compute" on the intrusion of privacy, the elimination of jobs, and the value conflicts of technology. The future quality of human life depends on it! —Edward Joyce

• index to advertisers •

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puzzle answers

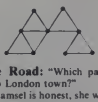
A Marbleous Puzzle: The number of black marbles in the white container is equal to the number of white marbles in the black container.

Sinbad's Hat: Any method of solution will show that Sinbad's rowing speed is irrelevant to the solution. The best solution is arrived at when one looks at the problem from Sinbad's vantage point: It looks to Sinbad as if he is in still water!! Therefore, since he rows away from the hat for 10 minutes, if he rows towards the hat for 10 minutes he will catch up with it. The hat (as we know) traveled 1 mile and it took 20 minutes . . . 3mph.

Two For The Show: Puzzle 1: One ought to owe nothing, for one ate nothing.
Puzzle 2: I understand you undertake to undermine my understanding.

It's Riddle Time: (1) 9 + 99/9 = 20. (2) When it is 8 o'clock and you add 6 hours to it, the answer is 2 o'clock. (3) Because it makes Ma Mad. (4) To keep his wig warm. (5) Because it makes the butterfly. (6) A timetable. (7) In the dictionary. (8) None. You have to pour them into the pot.

The Clue Club:



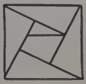
The Fork In The Road: "Which path would you say leads to London town?"

Forsooth. If fair damsel is honest, she will always say the London fork will lead to London. And so. In answer to Merlin's question she must also indicate the London path.

If fair damsel is dishonest then she will always say that the Manchester path (if the second path leads to Manchester) leads to London. But since she is dishonest, then in response to Merlin's query she must also indicate the London path.

It follows that regardless of whether fair damsel is honest or dishonest, in response to Merlin's query she must indicate the London path. Merlin proceeded on his way fully confident of arriving in London town. But having no idea of whether or not fair damsel was honest or dishonest. O Merlin, thy wizardry is inspiration to all us mere mortals who observe your artistry!

Many Into One:



June 1981 • Expires September 1, 1981

Creative Computing

(Please Print)

Name

Title

Address

City

State Zip

1 Which of these statements best describes the way you approach advertisements in **Creative Computing**
A I look for ads about specific products
B I make an effort to look at most ads
C I generally look at about half the ads
D I rarely look at ads

2 Which of the following actions have you taken after reading an advertisement in **Creative**? Check all that apply
A Asked for more information from advertiser
B Used a reader service card to obtain information
C Purchased/ordered a product from an advertiser
D Showed or sent an ad to someone else

3 Please check any of the following ways you purchase equipment
A Local computer store D Mail order
B Direct from manufacturer E Club group purchaser
C From systems house F Other

4 How long do you keep back issues of **Creative**
A Never discard them D 3 to 6 months
B Over 1 year E Less than 3 months
C 6 months to 1 year F Give to a friend, library etc

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SUBSCRIPTIONS TO CREATIVE COMPUTING

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☐ Renewal

Term	USA	Canada and Foreign surface	Foreign air
3 yrs (36 issues)	☐ $53	☐ $80	☐ $143
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1 yr (12 issues)	☐ $20	☐ $29	☐ $50

For a change of address, please attach old label

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	6B	Best of Creative Computing-Vol 2	8 95	
	12C	Best of Creative Computing-Vol. 3	8 95	
	6C	Basic Computer Games	7 95	
	6C2	More Basic Computer Games	7 95	
	6C4	More Basic Games-TRS-80	7 95	
	8F	Best of Byte	11 95	
	8G	Colossal Computer Cartoon Book	4 95	
	6H	Be A Computer Literate	3.95	
	8Z	Computer Rage Game	8 95	
	9Y	Problems for Computer Solution Teacher's Edition	9 95	
	9Z	Problems for Computer Solution	4.95	
	10R	Computer Coin Games	3.95	
	12A	Katie and the Computer	6 95	
	12D	Computers in Mathematics-A Sourcebook of Ideas	15 95	
	12E	Impact of Computers on Society and Ethics Bibliography	17.95	
	12B	Tales of the Marvelous Machine	7 95	
	12G	Computers for Kids-Apple	3.95	
	12H	Computers for Kids-TRS-80	3.95	
	12J	Computers for Kids-Atari	3 95	
	CR101	Computer Music Record	6.00	
	RSS	Sorting & Shuffling Reprint	50	
			SUBTOTAL	

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Quan.	Cat.#	Title	Price	Total

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