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THE ORIGINAL MAGAZINE FOR TRS-80™* OWNERS

H&E COMPUTRONICS INC.

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SPRING VALLEY, NEW YORK 10977
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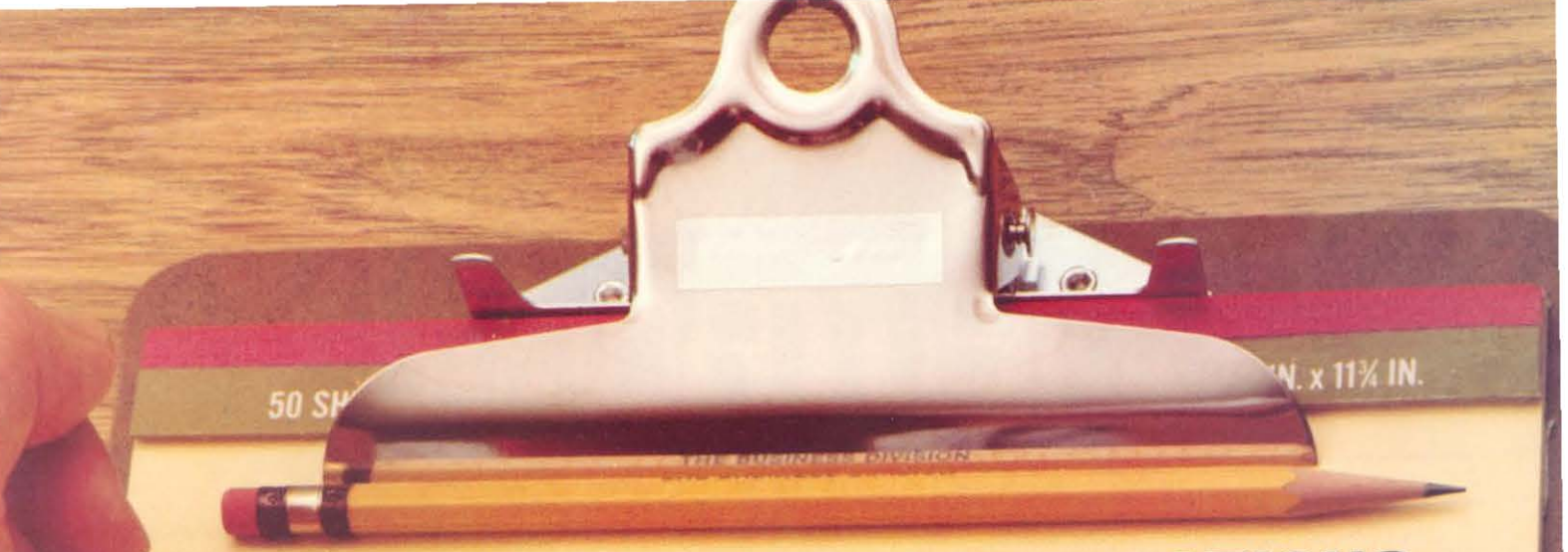

PLEASE ANSWER THESE 5 QUESTIONS

	YES	NO
1. Do you have information that must be kept organized and accessible?	☐	☐
2. Do you ever need to perform statistical analyses?	☐	☐
3. Would you like to have a tool that will allow you greater flexibility in managing your own or your company's money?	☐	☐
4. Could you use a mail list program that will be easy to use, maintain an unlimited number of names, allow you great sorting flexibility, and even interact with a word processor?		
5. Do you own or have access to a TRS-80 microcomputer?		

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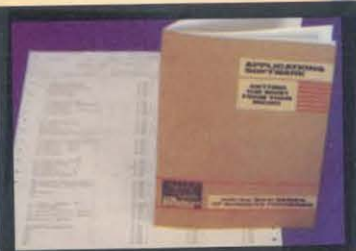

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DECEMBER 1982 **ISSUE NUMBER 52**

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BITS AND PIECES

Howard Y. Gosman

ON THE COVER

This month's cover reflects the introduction of our new, expanded version of our package for stock market entrepreneurs, THE MARKET PAC (originally the STOCK MARKET PAC, released in 1978). This is the latest effort by our long-time friend and associate, Dr. Peter Shenkin, Business Editor of *Computronics* and creator of the best-selling BUSINESS PAC 100 and MASTER PAC 100. We don't know how he does it, but he keeps turning out programs at a fantastic rate, and he now has many devoted followers worldwide (our overseas customers have always been especially enthusiastic about the BUSINESS PAC 100).

THE MARKET PAC will aid both financial professionals and individuals in the evaluation, selection, and management of investment portfolios. It features: coverage of stocks, bonds, convertible securities, options, warrants and annuities; realistic treatment of taxes and commissions; and portfolio selection methods. This package includes a complete Portfolio Bookkeeping system which will be invaluable in managing investment portfolios.

MODEL I CREATOR QUITS

Steven Leininger, Radio Shack's director of advanced development and the person who was virtually the sole designer of the TRS-80 Model I, has quit Tandy (as reported in *Computerworld*) after five years with the company. Radio Shack's not particularly worried, since their development staff now numbers over 200, compared to the original 12 technical researchers who helped develop the Model I. There's apparently no hard feelings - Tandy is certainly grateful for Leininger's contributions, and Leininger holds no grudges against Tandy. He reportedly just felt the need to be part of a smaller "upstart" company in order to make the most of his experience and ideas.

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The H & E COMPUTRONICS MONTHLY NEWS MAGAZINE is published by H & E Computronics, Inc., 50 North Pascack Road, Spring Valley, New York 10977. *The H & E COMPUTRONICS MONTHLY NEWS MAGAZINE* is not sponsored, nor in any way officially sanctioned by Radio Shack, a division of Tandy Corporation.

The purpose of the *H & E COMPUTRONICS MONTHLY NEWS MAGAZINE* is to provide and exchange information related to the care, use, and application of the TRS-80™ computer systems. H & E COMPUTRONICS, Inc. does not take any financial responsibility for errors in published materials. Users are advised to check and edit vital programs carefully.

The H & E COMPUTRONICS MONTHLY NEWS MAGAZINE encourages comments, questions, and suggestions. H & E COMPUTRONICS will pay contributors for articles and programs published in the magazine.

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The DOSPLUS 4.0 hard drive system is here!

A hard drive without the dynamic new DOSPLUS 4.0 is like an eggshell without the egg. The new DOSPLUS 4.0 is the leading edge–the latest in the line of advanced disk operating systems from MICRO-SYSTEMS SOFTWARE INC. It's the only current operating system written from the ground up for hard disk operation. Not just a driver but a fully developed system. What that means to you is more bang for your buck! Finally an unlimited TRS-80 for small business. For only $1899 you get the DOSPLUS "PLUS"

THE DOSPLUS 4.0 FEATURES

- Single volume addressing/Double sided floppies seen as one drive–one file can expand to limit of the hard drive
- Hard Disk—disk editing utilities
- Incredible I/O speed
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- BASIC array sort—multi key, multi array
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- Random access and ASCII modification on Diskdump
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NOTE: The final versions of 3.4 and 4.0 will have almost identical features and documentation.

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THE CRYSTAL BALL

(News and Rumors of Interest to TRS-80 Owners)

THE END OF THE MODEL III?

It seems like only yesterday that Model I owners got the news that their computer was discontinued—replaced by the Model III. The Model III is essentially a repackaged Model I, with the addition of double-density drives, and it's been even more popular than the Model I was. The Model I is a great computer, but its inevitable tangle of cables has always made it unsightly and prone to errors. The Model III's neat enclosure eliminated this problem and made the computer truly acceptable for most businesses (although, computer buffs who use the Model I for business purposes feel that it's just as good as the Model III).

Well, don't panic, but we have reliable information that the Model III will soon be replaced by another computer, name unknown (the Model IV?). As in the previous "replacement" of the Model I by the Model III, the new machine will be very similar to the Model III, and will be completely software-compatible, which should make you all breathe a little easier. Technology has moved so rapidly these last few years that Radio Shack would be foolish not to keep up. Naturally, we expect that support for Models I and III would continue as before.

What will the new machine be like? Well, we have a couple of good predictions and a lot of speculation. First, we can expect the new machine to *look* something like the Model III, with a complete system enclosure, but it will be significantly smaller. It may even be small enough to put a carrying handle on it and address the "semi-portable" market. One important feature that's bound to be included. The disk drives will be of the new "Slimline" variety — about half the size of the present drives, and twice the storage capacity. Since the Model III has double-density drives, look for *quad*-density in this next incarnation.

If the machine is really portable, then the screen itself may be smaller, with the possibility of an add-on full size screen—and we'd like to see Radio Shack make the full-size monitor a color monitor, adding COLOR BASIC commands from the Color Computer for high resolution graphics. One more point about the screen: Radio Shack, if you're reading this, PLEASE make it an 80-column screen! Business people the world over would love you for it!

It's hard to predict what other changes might be made. If Radio Shack wishes to increase their sales in the business market, which is where the money is, then they'll have to include some new features as *standard equipment* — like an RS232 interface, or maybe two, as in the Model II — and a built-in hard disk port (virtually everyone in business will have hard disks within two years). The new machine, like the Models I, II, III and 16, will undoubtedly have a break-in period where many troubles will surface and be corrected. But like the others, once the real problems are solved and the smoke clears, we'll see a new machine that equals or surpasses the competition in power, and beats them in price.

THE ELECTRONIC ECONOMY

The infant field of banking by computer terminal is a subject of great excitement, great controversy, cautious optimism and more than a little well-justified fear. A picture is being painted of a world in which we can complete any type of financial transaction instantly, right from the comfort of our homes and offices. If you want to buy a stock issue, a toaster oven, or a car; if you want to make a bank deposit, a transfer, or a loan payment, you can do it with the touch of a few keys on your microcomputer. Sounds convenient, right? Well the future may hold some major changes for us in the way we do business, and they're not necessarily all for the good.

Some of us, both in our personal budgeting and in our businesses, frequently rely on "cash flow" strategies. For instance: you lack an overdraft credit line on your checking account and you're a little short of cash this

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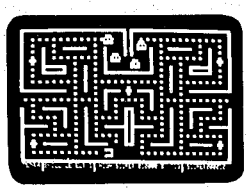
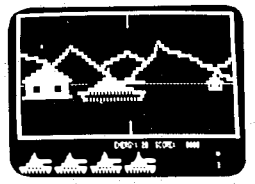
All photos are actual TRS-80 screens.



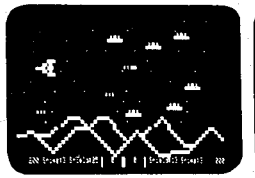
SCARFMAN

This incredibly popular game craze now runs on your TRS-80! It's eat or be eaten. You run Scrarfman around the maze, gobbling up everything in your path. Try to eat it all before nasty monsters devour you. Excellent high speed machine language action game from the Cornsoft Group. With sound. Price: A



ARMORED PATROL

A realistic tank battle simulation. Your view is a 3--D perspective of an alien landscape. Maneuver your T-36 tank to locate and destroy enemy tanks and robots that lay hidden, ready to assault you. Clever graphics create the illusion of movement and dimension. From Adventure International. With sound. Price: B

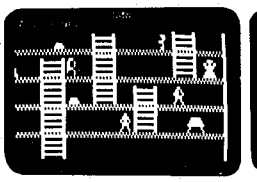


REAR GUARD

Deadly waves of enemy Cyborg craft attack your fleet from the rear. You are the Mothership's sole defender. You have unlimited firepower but the Cyborgs are swift, nimble attackers. Your abilities are tested hard in this game or lightening fast action and lively sound from Adventure International. Price: B

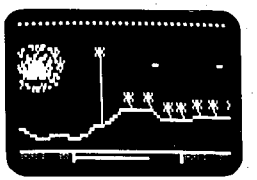
STRIKE FORCE

As the primary defender of a world of cities under deadly alien attack, your weaponry is the latest: rapid fire missiles, long range radar, and incendiary "star shells." Your force field can absorb only a limited number of impacts. A complex game of strategy, skill and reflexes from Melbourne House. Price: A



PANIK

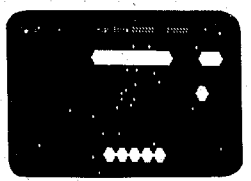
Trapped at an enemy building site, your fate seems certain. Your laser is empty and evil Mzors are closing in. You'll have to climb ladders and think one step ahead of the various monsters. A challenging game for agile minds. From Fantastic Software with voice (Disk has larger vocabulary). Price: B



SEA DRAGON

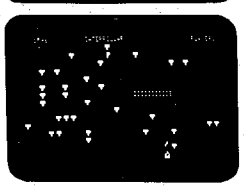
Your submarine, the U.S.S. Sea Dragon, penetrates a mined enemy channel. Armed with missiles and torpedos, you engage the enemy while navigating unknown waters. Succeed or come to a salty end in this game. 29 screens of horizontally scrolling sea-scrape and sound from Adventure International. Price: B

SAVE 10, 15, 20%



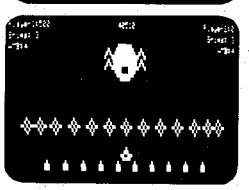
BOUNCEOIDS

Huge boulders careen off the walls. You're in the middle, in danger of being flattened. Keep your wits about you as you blast these "bounceoids" from the screen. Large ones break into many small ones. Clear a screen, and enter a fast-paced challenge stage with a chance for big bonus points. From the Cornsoft Group. Price: A



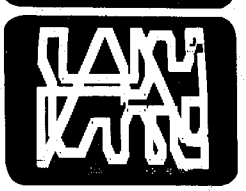
CATERPILLAR

An arcade favorite! Stop these multi-sectioned crawlers before they creep down through the mushrooms. Zap one and it splits into two smaller bugs, each with its own sense of direction. There are moths and tumble bugs too. It all adds up to lots of fun for kids and adults alike. From Soft Sector Marketing. With sound. Price code: A



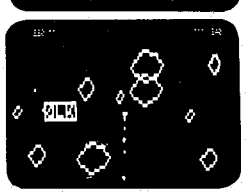
DEFENSE COMMAND

The invaders are back! Alone, you defend the all important nuclear fuel canisters from the repeated attacks of thieving aliens, repeatedly. An alien passes your guard, snatches a canister and flys straight off. Quick! You have one last chance to blast him from the sky! With sound and voice. Price: A



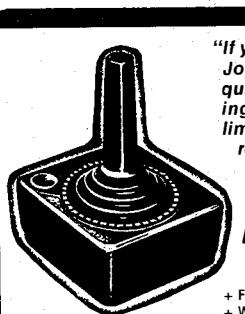
CRAZY PAINTER

You have to paint the floor white. We give you the paint and brush. Sounds easy? Hah! You'll be confounded by stray dogs, snakes, sloshing buckets of turpentine, even a ravenous "paint eater." A crazy, imaginative new game with ten selectable levels of skill for new or seasoned game players. Lot's of laughs. Price: A



SUPER NOVA

Asteroids float ominously around the screen. You must destroy the asteroids before they destroy you! (Big asteroids break into little ones). Your ship will respond to thrust, rotate, hyperspace and fire. Watch out for that saucer with the laser! As reviewed in May 1981 Byte Magazine. Price: A



"If you purchase Alpha's Joystick you get the exquisite pleasure of enjoying (action games) to the limit of arcade-style realism."

–80 Microcomputing 80 Reviews, Jan '82

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Price includes Joystick + Alpha Interface + Instructions + Demo Program listing. Please specify Model I or III.

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14 DAY MONEY BACK GUARANTEE

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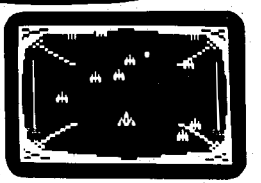
THE BEST FOR LESS

As you can see, all the best games from the top producers are joystick compatible. These games are fun without the joystick but we hope that you are one of the many thousands who enjoy the advantage of real joystick action.

Now you can deduct up to 20% on the price of games: buy any 2 games deduct 10%, buy any 3 games deduct 15%, buy any 4 games deduct 20% from game prices.

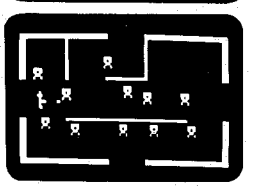
TOP TEN

1. SCARFMAN - *All time favorite*
2. ARMORED PATROL - *Super 3D graphics*
3. PENETRATOR - *Rave reviews*
4. STELLAR ESCORT - *Fast and Challenging*
5. CRAZY PAINTER - *Unique game concept*
6. PANIK - *Remarkable Voices*
7. DEFENSE COMMAND - *Tough struggle*
8. CATERPILLAR - *Good rendition*
9. ROBOT ATTACK - *With voice*
10. SEA DRAGON - *Amazing "Seascape"*



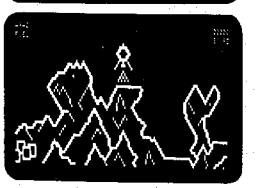
STELLAR ESCORT

The latest super action game from Big Five. As the Federation's top space fighter you've been chosen to escort what is possibly the most important shipment in Federation history. The enemy will send many squadrons of their best fighters to intercept. With sound. Disk version has voices. Price: A



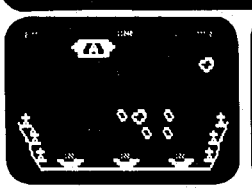
ROBOT ATTACK

Talks without a voice synthesizer, through the cassette port. With just a hand laser in a remote space station, you encounter armed robots. Some march towards you, more wait around corners. Careful, the walls are electrified. Zap as many robots as you dare before escaping to a new section. More robots await you. Price: A



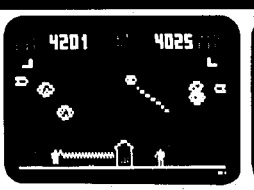
LUNAR LANDER

As a vast panoramic moonscape scrolls by, select one of many landing sights. The more perilous the spot, the more points scored -- if you land safely. You control LEM main engines and side thrusters. One of the best uses of TRS-80 graphics we have ever seen. From Adventure International. With sound. Price: A



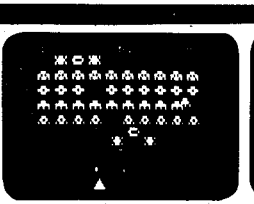
METEOR MISSION II

As you look down on your view, astronauts cry out for rescue. You must maneuver through the asteroids and meteors. (Can you get back to the space station?) Fire lasers to destroy the asteroids, but watch out, there could be an alien Flagship lurking Includes sound effects! Price: A



OUTHOUSE

You are the mighty protector of this small (but important) wooden structure. For reasons unknown, a bizarre gang of miscreants wish to vandalize, loot and otherwise destroy the little "half moon house." Your patrol craft has lasers and smart bombs to deal with this terror. From SSM with sound. Price: A

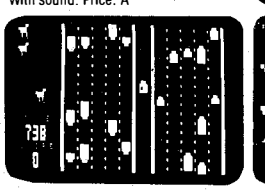


GALAXY INVASION

The sound of the klaxon is calling you! Invaders have been spotted warping toward Earth. You shift right and left as you fire your lasers. A few break formation and fly straight at you! You place your finger on the fire button knowing that this shot must connect! With sound effects! Price: A

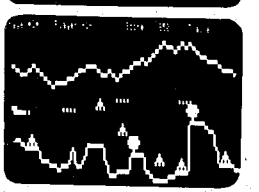
LASER DEFENSE

In this game of ICBM's, high-energy lasers and particle beams, you control the U.S. strategic defense satellite system. From your viewpoint high above the globe, you intercept Soviet nuclear missiles in flight and attempt to destroy their scattered missile silos. With sound from MED Systems. Price: B



CHICKEN

Will the chicken cross the road? That's up to you. Can you guide these helpless little chicks across the perilous 10 lane super highway to safety? Or will you bumble, littering the blacktop with a storm of chicken feathers? A humourous yet challenging game of nerves from SSM with sound. Price: A



PENETRATOR

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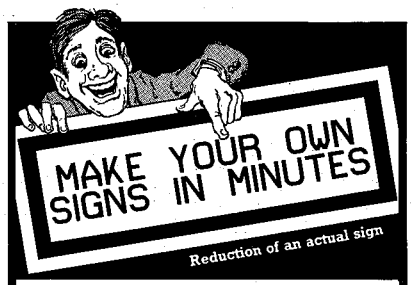

week—but payday is just the day after tomorrow, so you can cash a check at the local supermarket—even though your account balance may be close to zero. That check won't arrive at your bank until a day or so *after* your next deposit. Thus, you've taken out a loan on your next paycheck, without bank approval. Likewise, you can mail off a check in payment of your utility bill, knowing that it won't arrive until a deposit has been made to cover the check. These little day-to-day strategies will disappear if electronic banking becomes universal. The people who created the MasterCard have already introduced the MasterCard II, which is *not* a credit card, but a *debit* card — in other words, when you use the MasterCard II, it debits your checking account directly, rather than putting the charge onto your next credit card bill. Combine this type of checking account card with instant (maybe even 24-hour) banking, and you'll no longer be able to pass that check at the supermarket. When you present that card to the cashier, it will go straight into a machine that will be able to verify your account balance and *immediately* debit your account. If you don't have the funds in your account (or the credit) to cover the groceries, you're out of luck.

Transactions that are completed at the speed of light will have consequences for other areas than just our checking accounts. Market analysts and economists have found it more and more difficult to make accurate predictions as the speed of transactions is increased by electronic means. Things change too fast. Now, with the ability to get up-to-the second quotations and predictions on a small computer screen, and to register transactions just seconds later, the feedback time between your discovery of a tip or trend and the placement of your transaction approaches zero. Instantaneous nationwide (and international) reaction to market trends may not be exactly what we need to stabilize our economy. What we may have is a problem analogous to that of some physical and social scientists: the observer contaminates his observation by the very act of observing. Perhaps a better analogy would be in horse racing: suppose you get a hot tip about a horse that's really a sure bet to win. You see that the odds are *very* high against this horse, so a small bet is sure to make you a fortune. Now suppose that *everyone* has instant access to that same tip. Everyone instantly places bets on the same horse, so the odds quickly drop, and your bet won't make you a fortune after all. The instant-feedback effect has already shown itself in other areas of electronic communication: in the last Presidential election, computerized projections were made just after the polls closed on the East coast. The result was that people on the West coast were virtually cheated out of their vote. The early projections quickly showed that President Reagan would win, and West coast voters were dismayed by the sight of President Carter conceding the election *before the polls had closed*. Some economists visualize a light-speed economy shaking itself to pieces like a flywheel spun faster than its design limitation.

Universal electronic banking will also have an effect on our personal privacy. When every purchase and transaction you make is fed through and registered in a computerized system, the I.R.S. will really have a *very* accurate record available of every cent you earn and spend. Likewise, credit agencies and other companies that are interested in compiling a dossier on you will have less trouble doing so. Still more sinister is the possibility that certain groups (even criminal groups) will stick their noses into your business, examine your personal and business data, and perhaps even steal from you—and you won't even be able to detect them. Even now, vast data bases exist about our personal habits and preferences, about how we do business, and about our financial standing as credit risks. And more than one private group already exists with the explicit aim of controlling your economic behavior or forcing you to conform to their idea of morality. Some government (and non-government) agencies *already have* extensive files of this type on *all of us*.

Actually, we don't have to worry about all this becoming reality next week. The future of electronic banking is a subject of a lot of heated dis-

agreement among bankers themselves. Experimental programs have installed electronic banking facilities in many homes to test the market for these services. These tests have met with mixed results. Two articles in the October 4th *InfoWorld* dealt with this subject. One of the articles describes a recent conference of banking and computer people in New York City which illustrates the controversy over "Videotex" banking services. One research firm at the conference claimed that their survey shows a potential 50 percent market penetration of all U.S. homes by 1990, while an anonymous AT&T executive told *InfoWorld* that their tests gave a figure of only 7 percent by that time. A strong concern among some bankers was that the banks should be the sole provider of all aspects of this kind of service. Others disagreed. Even the transmission facilities for this type of system are in doubt—some favor continuing the use of the telephone system, while others suggest the use of cable TV lines.

Another *InfoWorld* article announces that Chemical Bank is ready to make an electronic banking and information service available by the end of the year, designed for some of their New York area checking account customers. The new service, called PRONTO, will be available for a monthly user fee of between $8 and $10, plus telephone charges for a Telenet or Tymnet hookup to the bank's computer in Somerset, New Jersey. Customers will be able to make a variety of banking transactions and call on electronic bill-paying, home budget management, electronic mail, and other services from their homes. Users will have a private "personal identification code" to prevent others from gaining access to their accounts. This could be a revolutionary experiment. However, right in the middle of this experiment is a very strange (and perhaps very bad) marketing decision. Although PRONTO will be ready to hook up to Xerox, Apple and IBM computers by late 1983, they have decided to introduce the service for just one computer. What computer do you suppose PRONTO has been designed for? With an incredibly wide spectrum of good machines they could have chosen, they picked the *ATARI*! Perhaps they think that Atari's success and their highly visible ad campaigns mean a big future for Atari's computers. Perhaps they think the low price makes the investment more attractive to the consumer. But as far as choosing a computer that's well designed for personal finance and other personal/ business applications . . . well, they might as well have chosen the SINCLAIR ZX81. PRONTO'S early customers will get stuck with machines that may be less than desirable to own. At the very least, it's a bad way to introduce the service—they should have picked a *real computer*. Best advice: wait until late 1983 before hooking up to this service.

COMPUTERS IN EDUCATION

As software packages become increasingly sophisticated, more and more microcomputers are finding homes in educational institutions and training departments of corporations. The possibilities of using computers for training are just beginning to be explored. Now, one of the most ambitious projects to date has been completed, and high school students can look to the microcomputer for help in preparing for the all-important SAT - the Scholastic Achievement Test.

For years, students have relied on expensive cram courses and cumbersome review texts to prepare for the SAT. Now Harcourt Brace Jovanovich, Inc., is offering COMPUTER SAT, which virtually acts as a private tutor to coach the student through the trials and tribulations of the monumental SAT exam. This is the first software-textbook package for personal computers that leads the student step-by-step through the complete test preparation process. The system actually diagnoses the student's strengths and weaknesses, prepares a study plan, and guides the student through a comprehensive set of study exercises. The COMPUTER SAT package consists of a 470-page textbook, *How to Prepare for the SAT,* two floppy disks, and a user's manual that guides the student through the system. The package integrates the software and textbook in a system

continued on page 8

issue, the price listed in this advertisement was incorrect. The price should have read $119.95. We are sorry for the inconvenience this may have caused you.

THE CRYSTAL BALL

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that combines the best aspects of each form of media. The current version for Apple computers sells for only $69.95, and a version for TRS-80 computers will probably be available in about 4 months.

The textbook contains four complete SAT practice examinations. The student takes one or more of these examinations, entering the answers into the computer by means of a simple program. The program scores the tests, analyzes the student's perpormance, and creates a personalized, prioritized study program. computer scoring provides the student with immediate feedback and features computer-presented explanations that help students learn strategies for success. The computer also times the student's performance to help develop speed as well as accuracy. The student receives detailed study assignments that include specific reading material in the text, specific problems to be solved, and specially designed math and verbal computer exercises.

An additional feature is "Vocabulary Flashcards" a program that provides drill and practice on 1,000 key vocabulary words. The computer keeps track of the student's performance and concentrates its presentation on the words the student needs to review.

COMPUTER SAT is also available in a special "Educator's Edition" which supplies multiple copies of the software and textbooks for classroom use. the Educator's Edition is priced at $395 and is distributed by Coronado Publishers, Inc. (a subsidiary of Harcourt Brace Jovanovich).

This publisher has been around for a long time, and they are recognized as one of the world's leading academic publishers. Their experience in producing exam preparation textbooks is well known, and this program is positively stuffed with those years of experience and insights. This is perhaps the most advanced training program yet to appear for a microcomputer, and they have kept the price down to a very reasonable level. Kids who have access to this system will undoubtedly have a great edge over their peers — when it comes to study-

ing for an exam like this, it would be very hard to find better motivation for most kids than the opportunity to sit down at the screen and converse with a computer. ■

BITS AND PIECES
continued from page 2

RADIO SHACK CREDIT CARD

Tandy Corporation has entered into an agreement with Citibank to create a new credit card (called the CITILINE card) to be used by qualified customers at Radio Shack stores within the continental United States. When you make an initial purchase of at least $225, you can apply to the store manager for the card. The manager will then call Citibank, where your credit will reportedly be approved (or denied) within about one hour (says Citibank). After the initial purchase, you can use the card for any purchase of $100 or more in Radio Shack stores. Although there are no service charges for cardholders, a 24 percent annual interest rate will be charged on the repayment schedule.

BUSINESS PROGRAMS IN BASIC

Another good book has been published aimed at businesses that use BASIC programs. *BASIC Computer Programs for Business, Volume 2*, by Charles D. Sternberg (Rochelle Park, NJ: Hayden Book Company, 1982. 384 pp., $13.95.) is an excellent collection of more than 70 complete programs for a wide variety of business applications. This type of book is an excellent alternative source of software for businesspeople who have some knowledge of BASIC programming. The extra effort required for this approach may be well worth it, since you are getting listings for programs that would otherwise be worth hundreds, or even thousands of dollars, for only $13.95.

Each program is fully documented and demonstrated with a description of its application and operation, a listing in BASIC, a symbol table, sample data and carefully formatted examples of printed output. This book provides a very wide spectrum of business programs (each program can, of course, be modified or incorporated into another program to meet the specific needs of any business). The book features sales and marketing programs for customer order processing, advertising monitoring, and customer service scheduling; personnel record-keeping systems; administrative aids, such as simplified word processing for correspondence, memos, and reports, mailing lists, price lists, and an electronic filing system; a variety of scheduling programs that can be used in any business operation; a collection of statistical programs that allows business data to be analyzed and compared; and file-handling programs for both sequential and random access files.

Ask for this book at your local computer bookstore, or call Hayden Book Co. at (201) 843-0550.

WHY WAIT?

The average microcomputer can send and receive data at 120,000 characters per second (CPS). Most disk drives can move data at about 27,000 CPS. However, most high-speed dot matrix printers have a top speed of only 120 CPS, and a typical telephone modem plods along at about 30 CPS. That's quite a drop in efficiency, and a great time-waster. Several devices are now available that help you get around this problem, and we're going to describe the best one yet (this one's so good, we've decided to sell it ourselves). We're talking about a little white box called the PRINTER OPTIMIZER. This device comes with its own internal memory—from 64,000 to 250,000 characters — and it has no trouble keeping up with your computer. You can send very long text files, or perhaps a complete inventory listing, into the OPTIMIZER's memory in just a couple of seconds—your computer will think that the printing is already completed. Then the OPTIMIZER will send the text to your printer, which will proceed to print the text as fast as it can—it might take 10 minutes or more to finish printing. Since the *OPTIMIZER* holds all of the text in it's own memory, your computer is free to go on and accomplish other tasks while the printer simultaneously continues to grind out your printouts. Now you (or your employee) won't have to sit around waiting, or take 10 coffee breaks in one morning while waiting for the printer to finish printing and free up the computer for its next task. Here's another plus: the

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LETTERS TO THE EDITOR

PRINT TAB(64)?

The fact that my Model I TRS-80's PRINT TAB statement will not accept an argument greater than 63 without executing a line feed causes problems in programming for a wide print-out. Is there a convenient solution, or am I stuck with inserting every space beyond #63?

Maureen Honish
2021 E. Hennepin Avenue
Minneapolis, MN 55413

There is a solution to the problem, but I'm not certain how convenient it is. Provided that you count the spaces that you have already printed, it is easy to work out: if J is the number of spaces that you have already printed and K is the column where you want to start printing, all you have to do is PRINT STRING$(K-J,CHR$(32)). This will print spaces out to the column where you want to continue printing.

Line Printer VII

I recently purchased a Line Printer VII from our local Radio Shack dealer. I have enjoyed the printer very much, as it does exactly what I bought it to do. I could, however, think of several things I would like it to do but I won't get into that in this letter.

The documentation supplied with the printer, like most Radio Shack manuals supplied with their equipment, leaves much to the imagination. One of the most interesting features of the Line Printer VII is the dot addressable graphics. The manual briefly brushes over the commands and gives only one poor example of a program.

I believe that many of your readers could benefit from an in-depth article covering the graphic capabilities of the Line Printer VII. I for one would be most appreciative to have such an article in my reference library. I am sending a copy of this letter to the other magazines to which I subscribe on a regular basis.

Robert E. Wesley, President
Leemor Attractions
116 Court St., #7
Plattsburgh, NY 12901

Are you listening, authors?

Typographical Errors

I have been distressed by errors appearing in some of your program listings, as well as by typographical errors in the text. Time for careful proofreading of the text should be allowed for in your publishing schedule. It seems that you do prepare program listings from machine-readable copies (accounting for the conversion of the up-arrow to a "greater than" symbol in some published listings). However, you may not run the program to be sure that it will work in the version you publish.

Let me cite two examples: the first is the program for mortization of loans, appearing in your January 1982 issue (#41). Line 100 did not work as published, for two reasons: lack of the up-arrow to indicate exponentiation (pointed out in a letter to you in issue #45) and a flaw in the formula used to compute the period payment, also in line 100. As published, the program gave increasingly negative amounts due, and produced overflow for amounts over $10,000. APR# entered as percent interest; it should be in decimal form for the calculations. A new line does this:

92 APR#=APR#/100

The exponent term in line 100 should carry a negative sign; the rest of line 100 following the up arrow should read:

(-PP%*YEAR): FF#=R#(1-II#):
PAY=FF#*LO#

This is based on calculation of payment from

$$PRIN\ (\ i\ /(1-(1+i)^{-n}))$$

and produces results agreeing with a "business analyst" calculator. If the program had been run before printing, the problem should have been evident. The two program runs referred to in the text of the article as being included were not published.

My second example is also a Zimmerman and Conrad article, the one to calculate depreciation appearing in your issue #40. The declining balance method option in that program does not give correct answers after the first several years, and continues depreciating on a straight-line basis to negative book values after the number of years selected for depreciation. I wrote you about this one in January, but have still not received an answer. I would still like to know how to get this program to run.

Your emphasis on business-related programs is beneficial to me; errors that prevent using the programs or result in extended time debugging a program before a correction is (hopefully) printed in a later issue are not. Perhaps you could consider offering tapes or disks containing your published programs at extra cost, as some of your competitors are doing. At the least, run the programs to verify that they will work in the versions that you plan to publish.

George F. McClure
1730 Shiloh Lane
Winter Park, FL 32789

Please be assured that we DO run every program before it is published, and we also try to proofread our program listings carefully. As you noted, however, mistakes will occur.

The main reason why errors get into our published versions is that we have transmission errors from our computers to the typesetting machines. The text that you read once existed as machine-readable code, and it was run on the computer, but was not transmitted properly.

Please continue to inform us of any errors that you encounter when reading the magazine, and we will endeavor both to prevent them from happening in the future and to publish corrections when necessary.

H & E Computronics welcomes letters on any subject. If you wish a personal reply, please enclose a self-addressed, stamped envelope.

H & E Computronics also welcomes readers to submit programs, articles, or reviews for publication. Please address correspondence to:

The Editor
H & E Computronics
50 North Pascack Road
Spring Valley, New York 10977

Please submit programs (and articles, if prepared with a word processor) on media (cassettes or diskettes). Also please indicate the system it was prepared on, and include any necessary instructions. ■

PROGRAM PREVIEWS

A. A. Wicks

This Month: DOS RANDOM ACCESS & BASIC FILE HANDLING BOOK

Recently, in anticipating the review of the book that follows, I asked several personal computer owners what their greatest problems were in organizing their own programming. With only one exception, the majority of those asked had difficulties with disk operation, and in understanding arrays. Certainly, although the sampling was small and unscientific, these people were not alone with their problems. Much has been written on arrays, it is still difficult to understand, and persons are troubled when working with them. Less has been written on disk operations, but it too, is an arcane subject.

Someone who had a problem with disk operations was H. J. Muller, author of the recent book about to be reviewed, *DOS Random Access & BASIC File Handling*. As with many TRS-80 users, Mr. Muller started as a neophyte in computers just a few years ago. His was a Model I, and, again as with others, he struggled up the learning curve. Because he was attempting to use the computer in his business applications, he was particularly frustrated when attempting to store data in Random Mode. He found others with whom he could commiserate, and the consensus was that there was not one "simple piece of literature that would tell the non-professional how to solve this problem," to quote the Author.

Together with a programmer named Carl Elhorn, Muller solved his problems eventually. The book is the result of his solution, and he passes this on to others, hoping it may save the pains that he underwent. The impression prevails that Muller is altruistic in his desire to provide this guidance, rather than attempting to make a profit on the book (although it is expensive).

The book avoids the "textbook" approach to learning. There are no little question-and-answer sections at the end of each Chapter (thank you!), no dissertations on the mechanics of a disk and drives, and so on. In a sense, there is no text at all. But there is a lengthy program listing, extensively and thoroughly commented upon — this is the text. This at first appears to be an unusual approach for a entire book of 145 pages, but on further examination it is one of the most useful approaches to learning that I have seen.

Be prepared to do a great deal of keystroking with this book, unless you purchase the disk, which is obtainable separately — this has the programs on it. Personally, I would recommend that if you have the time and talent, type the programs in; there is much to be learned by doing so, and you are more likely to study the line-by-line programming functions if you do.

The programs start out with a small address list program. The comments on the program then take two forms. First, each Section is discussed briefly. Then, in far greater detail, the Lines within each Section are commented upon. As a typical example as to how thorough this is throughout the book, take Line 200 for example. The program line reads: Clear 2000. This statement is discussed in the next 32 lines of text, in a simple and clearly stated manner than anyone could understand. But note that 32 lines of text to explain a Clear statement in itself provides a tutorial, which is beyond the basic title subject. Do not take this simplicity of explanation for granted however; knowledge of Level II BASIC is required for a complete understanding of the book. A general knowledge supplemented by reference to the Level II manual or other books will suffice, though.

Line 225 moves into the area of disk operations, with a file opening statement. For anyone unfamiliar with Random filing, the discourse that follows should enlighten them very quickly. And yet, the explanation and comments are not complex. The Author undoubtedly feels the insecurity of the student reader, and is gentle.

The guidance, comment and tuition continues in this vein throughout the remainder of the book. The program grows too, and other programs are developed, such as a payroll program (including income tax deductions), sorting programs, deletion subroutines, etc. Programs with graphic printouts are included, too, so that any reports that are developed appear professional in layout. Some of the other subjects described in detail are: LPrinting, Searching, File Compression, Fielding, Calculations from Disk File data, and, in associated areas not necessarily disk related, there is information on such things as verifying that the printer is "on line," setting the date into memory, using flags to prevent system "crashes," and numerous other routines. In the latter respect, this text goes further than its main title implies. It must, because so many disk operations interrelate to other computer operations. The Author has not been neglectful in this respect — he provides as much information and detail as he does for the main theme of the book.

Readers should have no difficulty in adapting any of the techniques given in the text to other applications. This is the intent too, of the book, as

the Author states, and he has presented it in just the right size "chunks" to aid this endeavor. A person could, in most respects, take the programs and modify them to their own needs. In doing so, they will learn exactly what each operation is doing, without necessarily knowing why it is happening. This is not a negative however, because the intent is to teach how, not why.

The writing in the book is, as mentioned, clear and understandable, and the Author's style is neither pompous nor frivolous. It is a change to read a computer book that lacks "cuteness" and alleged humor, which I personally find distracting, but others certainly may not. There are some spelling errors and some typographical errors in the text and in the programs, but not to any great extent.

The book is 8 1/2 by 11 inches, Perfect bound (glued spine) — therefore it will not, unfortunately, lie flat. It has a soft cardstock multicolor glossy cover. Printing is by the offset process on a good weight of white paper. Printing is by DSC Publishing of DSC, Inc., which appears to be a business associated with the Author. The text, which is on both sides of each sheet, has been composed on a Diablo printer using an OCR-B character wheel. This printwheel, normally used for optical character reading, is not a good device for text preparation — its use should be restricted to financial documents. Not that this should be construed as making the book more than a little difficult to read. Lower case letters, such as "l" and "i" are particularly diverting to the eye of the reader. The listings, being all in capitals and in the same type font, are excellent.

This book has an excellent Index. A subject is referenced on the same line in two ways — the page number, and also the paragraph number; or, where it applies, the Line number of the program. In reviewing the book, I found that by using the Index as a reference I could select rapidly and with accuracy, any particular part of the book that would be of importance in a review. Not having a "month of Sundays" at my disposal, I did not type in and run the extensive listings in this book. But if the program listings reflect the general accuracy of the text, there is no reason to suspect that there are any operating deficiencies in the programs. No information is provided regarding the availability and cost of the program disk that is referred to, so I was unable to check the programs by this method.

I can recommend this book without hesitation to anyone needing help in Random filing and working with BASIC files. The amount of information provided here will also be valuable as a learning tool, whether your applications are business (as in the book), or not.

DOS Random Access & BASIC File Handling — H. J. Muller, Author; C. P. Erhorn, Technical Editor. Available at bookstores, computer supply stores, and H & E Computronics, Inc. - **$29.95. Optional Program Disk for Model I & III add $28.50; for Model II add $32.50.**

A. A. Wicks
30646 Rigger Road
Agoura, CA 91301 ■

BITS AND PIECES

continued from page 9

OPTIMIZER doesn't just work with printers—it also works with *modems*, which are even slower than printers. You can use the OPTIMIZER to prevent your computer from being tied up when transmitting *or receiving* text over the phone.

In addition to being a time saver, the OPTIMIZER can access special letter-quality printer features that your word processing program alone can't handle. You can tell the OPTIMIZER to recognize user-selected code sequences, and to translate them into codes your printer can understand, to control underlining, boldface, graphics, font size, forms control, special symbols—anything your printer can do.

The basic OPTIMIZER, with 64K, is configured for a standard Centronics-type parallel port and costs $495. An adaptor is available for standard RS232C serial ports ($125) and you can install additional 64K memory cards for $125 each. The PRINTER OPTIMIZER is manufactured by Applied Creative Technology, Inc., and you can order or get more information directly from H & E Computronics at (800) 431-2818.

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PRACTICAL BUSINESS PROGRAMS

REGRESSION ANALYSIS WITH CONFIDENCE AND PREDICTION LIMITS

S. M. Zimmerman and L. M. Conrad

The objective of many engineering and business investigations is to make predictions about the future. One method of doing this is regression analysis, in particular, least squares linear regression analysis, with the addition of prediction and confidence limits.

The goal of this paper was to develop a program which could automatically calculate a least squares regression line, determine the prediction limits and the confidence limits, and then plot a picture of the results on either the TRS-80's cathode ray tube or printer.

We will briefly review the equations used in the program, then walk through a detailed example of how to use the program. Since our objective was a working program we will concentrate on the program, its use and operation with a minimum amount of time spent on the mathematical base upon which the program was based.

Linear Least Squares Regression

By least squares is meant a method of fitting a function to a series of data points such that the sum of the squares of the distance between the line is a minimum. In the case of a linear equation it is assumed the function will be a straight line. The equation which is being fitted is:

$$f(x) = a + b * x$$

Where a is the intercept
b is the slope

Prediction Limits

Prediction limits are limits which are placed around a least squares linear regression line which give the forecaster some idea of the variation that may be expected in individual points associated with the function used to generate the regression line. The equation for the prediction limits is:

```
(a+b*X(Ø))+-t(a/2)*S*SQRT(1+1/n+ n * (X(Ø)- Xbar)**2 / S(xx))
```

where a is the intercept
b is the slope
t(a/2) is from the t distribution with n-2 degrees of freedom
n is the number of data points
X(0) is the value of a particular point
Xbar is the average of the data
** means to raise a power
S(xx) is given below

```
S(xx)= n * sum x(i) **2 - ( sum x(i))**2
```

S may be calculated from the following equation:

```
S =(S(xx) * S(yy) - (S(xy))**2 ) / ( n * (n-2) * S(xx))
```

Where S(xx) is as given above and:

```
S(yy) = n * Sum y(i) **2 - ( sum y(i))**2

S(xy) = n * sum x(i) * y(i) - (sum x(i)) * (sum y(i) )
```

The use of the prediction limits like ever analyical tool must be used with knowledge and judgement. Such knowledge and judgement cannot be learned from a single paper.

Confidence Limits

The equation for the confidence limits which refers to the regression line itself is as follows:

```
(a+b*X(Ø))+-t(a/2)*S*SQRT(1/n+ n * (X(Ø)- Xbar)**2 / S(xx))
```

All variables in this equation are defined in a manner similar with the prediction limit equation already reviewed.

Remarks Relative to the Prediction and Confidence Limits

The prediction limits are wider than the confidence limits. This is as expected in that the prediction limits refer to the individual points and the confidence limits refer to the line. In both cases the further the data point under consideration gets from the mid point of the data, the wider the limits. This behavior is can be examined in detail with the plotting routines of the program.

RUNNING THE PROGRAM

The program starts out with the following credits and question:

```
REGRESSION WITH PREDICTION &
   CONFIDENCE LIMITS
LEAST SQUARES APPROACH
DEVELOPED BY
STEVEN M. ZIMMERMAN, PH.D. AND
   LEO M. CONRAD
NUMBER OF DATA POINTS?
```

The program may be used with computers with from 16k up. Depending upon the amount of random access memory available, a different size problem can be handled. The above question is designed to set the dimension of the arrays used in the program to match the capacity of the computer.

We inputted 100 because we had less than that number

continued on page 18

HARDWARE PREVIEWS

A. A. Wicks

This Month: MICROBUFFER™

It seems incongruous to be writing about Holiday gift giving in August, with the outside temperature over 100 degrees. But I wanted to be sure of sharing with you some information about a useful hardware item — which very well might become a "stocking-stuffer" for someone, about the time that this review is published. It may also prove to be an excellent investment for business computer use, such as when the operator cannot patiently wait to use the computer while the printer is printing a "dump."

The Practical Peripherals Inc. Microbuffer Model MBP-16K is produced for TRS-computer users who also have Epson MX-series printers (MX-80, -80F/T, and -100). This printed circuit board assembly will "buffer" 16384 bytes of data between the computer and the printer. That is, you may release up to that amount of data to the printer and then go right ahead using your CPU while the printer is printing the material.

The advantages of having a buffer will appear obvious to many. For those persons who perhaps may be unfamiliar with what a print buffer can do, the following may help. For instance, you have just completed a number of pages of text to your satisfaction in your latest word processing session. Without the print buffer you could go on until finished, utilizing computer memory and disk storage as normally — and going out for coffee and sandwiches while it was printing. With the buffer, you issue the print instruction — and continue with your processing. Another example would be in an office environment situation where payroll checks could be printing while other keyboard operations continue.

The 16K of buffering works out to about eight full pages of text - assuming an 80-character width per page, and 60 lines per page. However, in most cases, text or other material will not be "packed" this tightly on a page, so we are really going to be moving more than eight pages in most situations, probably. Nevertheless, you do not have to wait until 16K of data have been completely input before printing. Nor do you need to wait until the buffer is empty before sending more into it. The buffer is always waiting for input you might say, and challenges you to keep up to its capacity.

The Microbuffer MBP-16K is an extremely well-constructed circuit board just 3.9 by 4.7 inches (99 by 119 mm) in size, with excellent circuit traces and component indentifications — a professionally constructed assembly by any term of reference.

I had the pleasant opportunity to visit the large assembly line at Practical Peripherals, and observed these units being produced. I was quite surprised with the thoroughness of this production facility. Briefly, the empty printed circuit boards, which are manufactured elsewhere, are individually inspected upon arrival at Practical Peripherals. No assumptions are made regarding the quality of these boards, such as a one-in-ten or other such random check — inspection is 100%. Components are then installed by a rather large staff of assembly line persons, each having some particular installation assignment. The second inspection of each board is then performed, and the board goes off to the flow-solder machine, if visual inspection has been approved.

Following the flow-soldering process of the underside of the board, each is washed and again inspected — this time for the adequacy of the soldering task. Any deficiencies may then be touched up manually at this point. The interface connector is installed, and hand-soldered to the board.

The board is now ready for testing and "burn-in." If it tests OK, the burn-in commences, and if it survives (as most do), it is given final tests, including those that exercise every function while connected to MX-series printers. Following this, each board is carefully packed and readied for shipment.

Installing the MBP-16K in an Epson

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GUEST EDITORIAL

WHAT'S ALL THIS BROUHAHA ABOUT VIDEO GAMES?

Mike Shadick

There's been a distended amount of dissention heard lately — from various and sundry sources, many of them supposedly parental in nature — regarding a new and alledgedly vicious device which is threatening to 'invade" our homes and commandeer our young people's very lives.

The alleged culprits — and one would think that they were about to swallow up America in one fell swoop, to listen to their detractors — are what many of know and love as *video games*. The arcade variety, in particular, has recently fallen into no small measure of disrepute among some, largely due to profoundly protective parents who feel that their offspring are somehow spending inordinate amounts of time and/or money in Pac-Manish pursuits and the like.

Is this objection on the part of parents and others, a valid one? On a purely financial level, it may very well be.

Yet on any other level, parental objections to their sons and daughters devoting excessive amounts of time and effort at playing Space Invaders, *ad videum*, are completely invalid. Indeed, all available statistics fly in the face of such objections. For example: young people — and adults, for that matter — who enjoy playing video games, also enjoy much lower *crime* rates than the general population, which is to say that the vast majority of video game players are good guys, not the bad guys that their parents seem to be depicting them as being.

Though a cause-and-effect relationship between the two factors (video game-playing and crime-shunning) cannot as yet be empirically proven, nevertheless it seems safe to surmise, based upon available data, that video game-playing does in fact contribute to lower crime rates.

Moreover, video games can and do enhance the player's intelligence, and can even *increase* it — at least, as measured by the Stanford-Binet Intelligence Quotient (I.Q.). A recent experiment conducted among San Francisco teenagers by University of California psychologists, strongly indicated that avid video game players not only score higher in the Stanford-Binet test than do non-players, but that the players also score higher than they themselves had previously scored, prior to becoming videophiles.

UCLA psychologists have concluded that video games can actually serve to increase reasoning skills, and that they (the games) most certainly do not diminish intelligence by *any* measure!

Do video "war" games (such as Space Invaders) increase the violence levels in their players? Quite the opposite! In fact, the games provide an outlet for some inherently violent tendencies, and thereby serve to actually help *dissipate* violent attitudes in a harmless — and *effective* - manner.

That fact is bolstered by the virtually non-existent crime rate among avid video game fans. And common sense tells you the same thing! Any individual who spends significant blocks of time in pursuit of gamesmanship (or gameswomanship!) obviously has less time to spend in less-positive pursuits. It's as simple as that.

Parents and others who criticize their kids for playing video games - and who also criticize video arcade operators for catering to the youth - are missing the whole point. For video games are not a part of today's problems; rather, they are part of the *solution!*

Why is video gamesmanship such a rapidly-growing phenomenon throughout the country — and, indeed, throughout the free world? One reason certainly is that it fulfills so many basic human needs in ways that few other activities can match. Though the exact nature of human interaction with the games is not yet fully understood, one thing is clear: the inter-

action has a myriad of positive benefits. Indeed, the only "negatives" are in the minds of people who somehow feel threatened by the new technology reflected in the games, and by its rapidly-growing popularity, especially among youth.

My suggestion to those who do feel intimidated by the games, and who thus oppose their growing proliferation, is that they — their detractors — merely take a closer look at exactly what it is that they are opposing! If those parents and other so-called concerned citizens would just take a little time out of their busy schedules to actually *play* a few video games, they would undoubtedly be better able to perceive just what it is that their children find so completely compelling about them. In point of fact, a lot of the parents would probably find themselves joining their kids in becoming avid videophiles themselves.

Just imagine what might happen to the crime rate *then!*

Michael Herbert Shadick
Cedar Square West, Apt. E-414
1515 South Fourth Street
Minneapolis, MN 55454 ■

HARDWARE PREVIEWS
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printer may be done without difficulty, and requires no tools other than a screwdriver. The top cover of the Epson is removed and the MBP is plugged into the auxiliary interface socket connector. The cover is replaced — and essentially, that is all there is to the actual installation. However, not to over-simplify the operation - there are a number of steps that are taken in removing the cover, and other specific details that are clearly and adequately specified in the procedures that accompany the unit.

Next, the printer is turned on, and the normal Epson self-test may be run, which prints a continuous test pattern of all available characters. Assuming that everything checks out satisfactorily, you now connect the printer to the computer. With the MBP-16K installed, the standard interface is no longer functional, so the Epson parallel cable is connected to the MBP. The only difference in operation will be that the printer SELECT signal is not supported. Nevertheless, there is full compatibility with all other Epson commands, and with GRAFTRAX, if it is installed also. As a point of interest, according to a Practical Peripherals' officer, Epson America Inc. has checked the MBP-16K, and has stated that it is "safe for use" with the Epson printers.

The Instruction sheet that accompanies the Microbuffer is brief but adequate. The Installation Instructions Section is particularly thorough and detailed, and no one should have any difficulty in this repect.

This useful and technically superior device is modestly priced at $159.00. Practical Peripherals does not sell directly to the consumer, but there is a large distributor and dealer network offering this item and other Practical Peripherals devices, worldwide. Check with your regular computer hardware supplies dealer for availability.

A. A. Wicks
30646 Rigger Road
Agoura, CA 91301 ■

BITS AND PIECES
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EXTEND PRINTER RIBBON LIFE

If you own a printer that uses spool-fed ribbons, here's a product you'll want to get. It's generally recognized that considerable savings can be realized by the reinking of printer ribbons, because ribbon fabric can last much longer than the ink in the ribbon lasts. As a result of this, many companies have appeared that specialize in reinking printer ribbons. A better solution would be to get your ribbons to *reink themselves automatically.* This invention is an example of truly inspired creativity: an idea that is beautiful in its simplicity and effectiveness. The INK STICK is a small bottle full of ribbon ink is affixed to the interior of your printer. A stiff wick sticks up out of the bottle's cap, and as the ribbon advances, it rubs against one side of the wick, constantly reinking itself. An adhesive cup holds the bottom of the bottle firmly in place; to refill the bottle, you just lift it out of the printer, refill, and replace. The idea

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PRACTICAL BUSINESS PROGRAMS
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of data points and we knew this was within the limits of our 16k memory.

The next question is:

```
WARNING

USE CODED DATA
DETAILS (Y/N)?
```

All computers have limits on the size variables which they can handle. It is possible to run into some problems when numbers become very large. If you answer Y to the above question you will be given the following warning:

```
REGRESSION ANALYSIS REQUIRES THE CALCULATION
OF SOME VERY LARGE NUMBERS AND THEN FINDING
THE DIFFERENCE BETWEEN THESE LARGE NUMBERS.
THE TRS-80 SOMETIMES FAILS TO PROVIDE THE
ACCURACY NEEDED TO GET ACCEPTABLE RESULTS
WHEN THE DATA IS NOT CODED.

ENTER TO CONTINUE?
```

It is difficult to predict when the computer has failed to produce good results. One way that has worked for us, is to go through the plotting routine. If the line does not fit the data you know something is wrong.

After hitting the ENTER key the program continues:

```
INPUT DISK, KEYS, READ, TAPE#-1
OR TAPE#-2 (D/K/R/T1/T2)?
```

Regression analysis often involves the handling of large quantities of data. We decided to use all the alternative data input and data storage methods we could. If you do not have a disk system there is no sense in trying this option. If you do not have a second tape recorder this will not work either.

In line 930 is the DATA statement to be used for the READ (R) option. The order of data input starts with a value of X followed by a value of Y. The last two numbers must be 9999,9999 to terminate the read instruction.

We will use the KEY, (K) option for our illustration. After typing K and hitting the ENTER key you will see:-

```
DISK SYSTEM OR LEVEL II BASIC (D/B)?
```

Depending on the method of input and the system underwhich your computer is working there are some statements that must be excuted and others which cannot. The computer must be told what type of system is being used. It will have to told this several times during the selected operations.

After you have identified the type of system you are on and hit the ENTER key you will see:

```
1 X AND F(X) 9999,9999 TO STOP?
```

This question allows you to input data until the task is complete. Assume you inputted the following data:

```
X       F(X)
1Ø      9ØØ
11      976
12      98Ø
13      99Ø
14      1ØØØ
15      11ØØ
16      111Ø
17      12ØØ
18      125Ø
19      13ØØ
2Ø      16ØØ
9999    9999
```

After typing in 9999,9999 and hitting the ENTER key the computer will produce the following on the screen:

```
I  X   F(X)   I   X   F(X)
1  1Ø  9ØØ    2  11  976
3  12  98Ø    4  13  99Ø
5  14  1ØØØ   6  15  11ØØ
7  16  111Ø   8  17  12ØØ
9  18  125Ø   1Ø 19  13ØØ
11 2Ø  16ØØ  12  9999 9999
OUTPUT MENU
(NO) CHANGE, (-1) TAPE#-1, (-2) TAPE#-2, (-3) DISK,
(-4) ADD VALUES, (-5) PRINTER, (-6) CRT ONLY?
```

You may correct the data if necessary, save it on tape or disk, add values or continue with the analysis. We will assume you selected -6 for CRT, screen output, and continue.

There will now be a delay, the length of which depends on the amount of data being analyzed. The next thing you will see on the screen is:

```
F(X)=291.091 + 55.7818 * X
ACTION MENU
PLOT, FORECAST, NEW RUN, OUTPUT MENU, END
(P/F/N/O/E)?
```

The plot routine plots a picture of the data, the line, and either the confidence limits or prediction limits on the screen. If you have specified printer output this routine will also copy the results on your 80 column printer.

The forecast routine allows you to input any value for X and any value for t from the Student distribution and obtain a forecast of the expected value of the function, the value of the upper and lower prediction and confidence limits.

A new run may be called for. If you do this, all data and other information is wiped out.

You may return to the output menu for the purpose of correcting data, adding data or turning on the printer, or you may end the program.

We will assume you selected P for PLOT and hit the ENTER key. The next thing you will see is:

```
REGRESSION LINE (1)F(X)= A+B*X (2) NONE?
```

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BITS AND PIECES

continued from page 17

couldn't be simpler. It works very well in our Texas Instruments printer. The INK STICK sells for $5 and is being distributed by Lawrence Electronics of 3651 N. Cicero Avenue, Chicago, IL 60641. Look for it on the shelves of your local computer store (or ask for it if you don't see it).

THE INSTRUCTOR'S SYSTEM

A new software system by Microsoftware Services is designed to aid teachers in many aspects of their work, using a TRS-80 Model III. THE INSTRUCTOR'S SYSTEM consists of three programs:

RECORDS is a sophisticated record keeping system that stores an alphabetized class roster and grades for each student. It can print grade lists, comprehensive student records, and class statistics. When the semester is through, RECORDS calculates final grades with a formula you specify and stores these grades on diskette.

EXAMS is used to create, modify, store and print multiple choice or true-false exams. You type in questions and then quickly edit them with a built-in word processor, delete old questions, insert new ones, or select questions from prior exams. A key word search option is included to help you search old question files for items containing any word or phrase that you specify.

EXAMINER allows you to administer tests created under EXAM using the TRS-80 as a teaching machine. At the instructor's option, the computer can give the student instant feedback, which may make test-taking a better learning experience. After each student finishes an exam, it is automatically graded, and a detailed performance profile is created and stored. A class summary of responses to each question is also generated. If desired, EXAMINER will transfer class grades into the RECORDS files.

If you are interested in THE INSTRUCTOR'S SYSTEM, contact Microsoftware Services, P. O. Box 776, Harrisonburg, VA 22801, (703) 433-9485. ■

PROGRAM CONVERSION

will resume next month.

PRACTICAL BUSINESS PROGRAMS

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You have the option of plotting the data with your regression line or plotting the data by itself. We will assume you selected option 1 and hit the ENTER key.

The next thing you will see is:

LEVEL OF LIMITS 2...3?

The t factor to be used depends on the significance specified in your problem. We have left it to the individual to look up this value on either the Student distribution for small sample sizes or the normal distribution for larger samples sizes. We have used 2 in our example.

The next question is:

CONFIDENCE INTERVAL OR PREDICTION LIMITS (C/P)?

You may plot either confidence limits or prediction limits. You cannot plot both. The reason we did not include the option of plotting both is that. in our experience the picture that resulted was not meaningful. The plotting ability of the TRS-80 is too limited for this purpose. We selected C for confidence limits for our example.

The next quesion is:

LOW POINT OR ORIGIN (L/O)?

You have the option of plotting from the low point of your data or from the origin. Which is best depends on the problem under study. We chose to use the origin for our example.

The next question is:

HIGH POINT OR PROJECTION (H/P)?

You may select the high point of your graph as well as the low point. If you project far beyond the limits or your data you will see the confidence and prediction limits expand rapidly. We selected H for our sample run.

The program now clears the screen and plots the results.

PROGRAM LISTING

```
10 CLEAR 500: B$="D": CLS : PRINT CHR$(23): GOTO 60    :REM
  "PREDICT/BAS"
20 CLS : PRINT CHR$(23): PRINT "WARNING ": PRINT : PRINT "USE
CODED DATA": INPUT "DETAILS (Y/N)";Y$: IF Y$="N" THEN RETURN
30 CLS : PRINT "REGRESSION ANALYSIS REQUIRES THE CALCULATIONS
OF SOME VERY LARGENUMBERS AND  THEN  FINDING  THE DIFFERENCE
 BETWEEN THESE LARGE NUMBERS.  THE    TRS-80    SOMETIMES
   FAILS   TO  PROVIDE THE ACCURACY NEEDED";
40 PRINT " TO GET  ACCEPTABLE RESULTS WHEN THE DATA IS NOT
CODED."
50 PRINT : INPUT "ENTER TO CONTINUE";D$: RETURN
60 PRINT "REGRESSION WITH PREDICTION &      CONFIDENCE
LIMITS": PRINT "LEAST SQUARES APPROACH": PRINT "F(X)=  A + B *
X ": PRINT "Copyright ": PRINT "STEVEN M. ZIMMERMAN, PH.D. AND
      LEO M. CONRAD   1982 ":I=0
70 INPUT "NUMBER OF DATA POINTS";G: DIM X(G),F(G): GOSUB 20
80 CLS : PRINT CHR$(23): INPUT "INPUT DISK, KEYS, READ,
TAPE#-1 OR TAPE#-2 (D/K/R/T1/T2)";IN$: IF IN$="D" THEN
LINEINPUT "INPUT FILE:DISK  ";D$: OPEN"I",1,D$
90 IF IN$="D" THEN B$="D" ELSE INPUT "DISK SYSTEM OR LEVEL
II BASIC   (D/B)";B$
100 IF IN$="T1" OR IN$="T2" THEN INPUT "SETUP TAPE RECORDER
TO PLAY";DU$: IF B$="D" THEN CMD"T"
110 I=I+1: IF IN$="T1" THEN INPUT#-1,X(I),F(I)
120 IF IN$="T2" THEN INPUT#-2,X(I),F(I)
130 IF IN$="R" THEN READ X(I),F(I)
140 IF IN$="D" THEN INPUT#1,X(I),F(I)
150 IF IN$="K" THEN PRINT I;: INPUT "X AND F(X) 9999,9999 TO
STOP";X(I),F(I)
160 IF F(I)<>9999 AND X(I)<>9999 THEN 110
170 CLS :N=I-1: IF B$="D" THEN CMD"R": CLOSE
180 PRINT "I  X   F(X)       I X  F(X)"
190 K=0: FOR I=1 TO N STEP 2: PRINT I;X(I);F(I),I+1;X(I+1);
F(I+1):K=K+2: IF K=32 THEN INPUT "ENTER TO CONTINUE";DU$:K=0
200 NEXT
210 PRINT "OUTPUT MENU":INPUT"(NO) CHANGE, (-1) TAPE#-1, (-2)
TAPE#-2, (-3) DISK,             (-4) ADD VALUES, (-5)
PRINTER, (-6) CRT ONLY";NO:I=0
220 IF NO>-1 THEN INPUT "X AND F(X)";X(NO),F(NO): GOTO 180
230 IF NO=-4 THEN LET I=N: IN$="K": GOTO 110
240 IF NO<-4 THEN 330
250 IF NO=-1 OR NO=-2 THEN INPUT "DISK SYSTEM OR LEVEL II
BASIC (D/B)";B$: IF B$="D" THEN CMD"T"
260 I=0: IF NO=-3 THEN LINE INPUT "OUTPUT FILE:DISK ";D$:
OPEN "O",2,D$
270 I=I+1: IF NO=-1 THEN PRINT#-1,X(I),F(I)
280 IF NO=-2 THEN PRINT#-2,X(I),F(I)
290 IF NO=-3 THEN PRINT#2,X(I),F(I)
300 IF F(I)<>9999 AND X(I)<>9999 THEN 270
310 IF B$="D" THEN CMD"R": CLOSE
320 GOTO 210
330 SX#=0: SY#=0: S2#=0: SC#=0: TX=0: TY=0: BX=99999:
BY=99999: S3#=0: S4#=0: S5#=0: SA#=0
340 FOR I=1 TO N: SX#=SX#+X(I): SY#=SY#+F(I):
SC#=SC#+F(I)*X(I): S2#=S2#+X(I)*X(I): S3#=S3#+X(I)*X(I)*X(I):
S4#=S4#+X(I)*X(I)*X(I)*X(I): S5#=S5#+F(I)*X(I)*X(I):
SA#=SA#+F(I)*F(I)
350 IF X(I)<BX THEN LET BX=X(I)
360 IF X(I)>TX THEN LET TX=X(I)
370 IF F(I)<BY THEN LET BY=F(I)
380 IF F(I)>TY THEN LET TY=F(I)
390 NEXT : ZX=N*S2#-SX#*SX#: ZY=N*SA#-SY#*SY#:
ZZ=N*SC#-SX#*SY#: SE=SQR((ZX*ZY-ZZ*ZZ)/(N*(N-2)*ZX))
400 IF NO<>-5 THEN 440
410 LPRINT " REGRESSION  WITH PREDICTION LIMITS LEAST SQUARES
APPROACH": LPRINT "  F(X)= A + B * X   ": INPUT "TITLE";D$:
LPRINT D$: INPUT "DATE (MM/DD/YY)";D$: LPRINT D$: INPUT
"OPERATOR";D$: LPRINT "OPERATOR: ";D$
420 LPRINT "I  X  F(X)      I   X  F(X)"
430 FOR I=1 TO N STEP 2: LPRINT I;X(I);F(I),I+1;X(I+1);
F(I+1): NEXT
440 B=(SX#*SY#-N*SC#)/(SX#*SX#-N*S2#):
C2=((SX#*S2#-S3#)*(SY#*SX#-SC#)-(S2#*SY#-S5#)*(SX#*SX#-S2#))
/((S2#*SX#-S3#)*(S2#*SX#-S3#)-(SX#*SX#-S2#)*(S2#*S2#-S4))
450 B2=((S2#*SY#-S5#)-C2*(S2#*S2#-S4)) /(SX#*S2#-S3#):
A2=(SY#*SX#-B2*SX#*SX#-C2*S2#*SX#)/SX#
460 A=(SY#-B*SX#)/N:C=SC#/S2#
470 XB=SX#/N
```

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Arne Rohde

5.3 Disk Arrays

Data arrays may contain more information than can be stored in internal memory. In these cases external memory must be used, with disk memory being the most common storage method for large arrays. Tape can also be used, but because of the speed limitations inherent in the medium itself it will probably only be used for small applications. For cassette tape sequential searching is the only method available, but some cartridge and reel to reel tapes can be read in reverse to provide for a form of non-sequential searching.

Disk files with random access mechanisms provide the means for performing efficient searches in large arrays. Sequential search techniques can, of course, also be used for disk files, but they will probably be too inefficient for all but the smallest arrays. Unless, of course, the disk operating system does not allow for random access to records within a file. In TRSDOS Basic, random access can be specified when the file is opened, and for this access method each record in the file must be of the same length. Various methods are provided for ensuring this, both for records containing numeric values and string values.

All of the non-sequential techniques covered above can be used with disk files, but obviously some are better suited than others. Normally the ones requiring the least number of compares are to be preferred, and often disk space will not be as critical as internal memory so that the techniques trading space for execution speed will be more usable. Thus direct lookup and hash code techniques will often be even more useful for disk files. The hash code array should use linked records to provide the least number of disk accesses.

Combination techniques are also available. If the data portion of each record is large compared to the key portion, then the key portion could possibly be stored internally with a pointer to the appropriate disk record number. This would provide for internal access to the keys, with disk access only being required to access the data portion of the required record. This could be used, for example, for name and address records in a customer file, where the name and address uses a large amount of storage compared to the customer number. The customer number array could be sorted internally to provide for non-sequential search techniques without changing the sequence of the records on the disk.

The above technique with a separate index to the file is usually known as indexed sequential or indexed file access, and there are many methods available for implementing it. In many cases the index will be stored on the disk, sometimes as a portion of the actual data file, sometimes as a separate file. A particular file may also have more than one index if it is to be accessed in more than one sequence. The main advantage of indexed sequential files is that they can be accessed both randomly and in key sequence, depending on the actual requirements.

5.3.1 B-trees

A special form of tree structure suited to disk file processing is the B-tree. I do not know the origin of the name, but it differs from the binary tree in that each node may have more than 2 subordinate nodes. If the maximum number of subordinate nodes is n, then the tree is called an n-way B-tree. The value of n is chosen so that as many keys as possible can fit into a single disk sector or block, together with the associated pointers to the subordinate nodes. Within each block the keys can be positioned sequentially, and only the leaves themselves need to contain data other than keys and pointers.

We shall assume a disk sector size of 255 bytes, a key size of 2 bytes (integer from 0 to 32767), and a pointer needing 2 bytes (up to 32767 sectors per file). A byte will also be used to indicate whether a sector is a data sector or an index sector. This leaves 254 bytes for the index, or 63 indices in an index sector, giving a 63-way B-tree.

The key value in each index item is the value of the highest key in the data or index block which is pointed to by the associated pointer. Thus each index block can point to 63 subordinate index blocks or to 63 subordinate data blocks. Because of the method used for inserting new records, the pointers must all point to index blocks, or all point to data blocks. Thus each node in the tree will be resident at the same level, and there will be a guaranteed maximum search depth to find any particular record.

The root sector address should be known at all times so that the root sector can be found easily to begin the search. To speed up the search, the root sector could be held in main memory while the file is being used. This can speed up searches considerably. If we assume a data record length of 127 bytes we can have two data records in each data sector, besides the byte to indicate a data record. Thus with only the root index sector we can access up to 63 data sectors or 126 data records with only two disk accesses. With more than 126 data records two or more levels of index will be required, but even with only two levels we can store up to 63*63*2 or 7938 records. With our assumed record length this is more than we can store on four 80-track diskettes in double density!

Because of page width limitations a 63-way B-tree can be difficult to draw, so for illustration we will assume a 4-way B-tree. The tree has two levels of index, and the data is at the third level. The tree could be drawn as follows:

B2 I 44 3 117 5 -1 -1 -1 -1

B3 I 12 4 23 6 44 10 -1 -1 B5 I 88 7 94 8 107 11 117 9

B4 D 5 data 12 data B6 D 13 data 23 data B10 D 32 data 44 data

B7 D 88 data B8 D 94 data B11 D 107 data B9 D 117 data

Bn indicates relative block number n within the file, I indicates an index block and D indicates a data block. The

numbers indicate key values and sector pointers alternately. Thus the root index sector (sector 2) points to two subordinate sectors, the first (sector 3) containing 44 as the highest key value, the second (sector 5) with 117 as the highest key. Sector 3 points to 3 subordinate sectors, each of which are data sectors containing 2 data records.

If we wish to insert a new data record with key value 18 the logical point to insert it would be in sector 6 which already contains the key values 13 and 23. Since we can only have two data records in each sector, the sector will have to be split to make room for the new record. We can leave keys 13 and 18 in one sector and create a new data sector for key 23. To keep the index up to date index sector 3 must be changed. Fortunately there is room for a new key and pointer, so key 18 is inserted to point to sector 6 and key 23 is changed to point to the new data sector, for example sector 12.

To insert a record with key value 111 we first find the sector containing the record with key value 117, since this is the next record in the file with a higher key value. There is room for a new record in the sector, so the new record is merely inserted with no changes in the index being required. Next comes a record with key value 115. This should be inserted into the same sector, but now there is no room for a new record. As for key 18 the data sector must be split, and records 111 and 115 are left in one sector and a new data sector (sector 13) is used for key 117.

The next problem arises when the index sector (sector 5) is to be updated, since it already contains 4 keys and pointers. There is no room for the new key (115) and corresponding pointer. This sector must then also be split, but instead of just moving key 117 to the new sector, it is split so that neither of the new index sectors contains less than 2 keys and pointers. This leaves room for expansion in both the new index sectors, and thus delays further splitting when new records are inserted. We can leave keys 88, 94 and 107 in one sector, and move 115 and 117 to the new index sector. Since we have created a new index sector, the index at the next higher level must also be changed. This is the root sector, which has room for two new key values and pointers, and thus 107 can be inserted as a new key value, and the pointer associated with key 117 changed to point to the new index sector.

If the root index sector had already been full, it would also have to be split, and a new root sector created in the file. If the root sector is always desired to be located in a particular place, for example relative sector 1, then the split root could be placed in two new sectors, and the new root left in the old sector. It should also be noted that when an index sector is split it must be possible to find the index sector at the next higher level. This could either be done by having backward links in each index sector, or by storing the path which is taken to find a particular data record. In most cases only a few sector numbers will have to be stored, namely the numbers of the index sectors which have been accessed to find the particular record, and this will be very limited even for very large files provided the key is short.

The maximum number of levels which must be accessed to find a particular record can be calculated. Because of the method used for splitting the index sectors, all except the root sector will contain at least half the possible maximum number of keys, or 32 in our earlier example. If the root node is full, then at least 32*63 records can be accessed with only two levels of index. This is over 2000 records, and as we saw earlier the maximum is over 8000 records with just two index levels. By comparison a balanced binary tree would require log2(2000) or 11 accesses to find any one of 2000 records. An unbalanced tree could require considerably more, in the worst possible case up to 2000 accesses.

Other splitting methods than the one described are also possible. One of them is to look at the next index sector at the same level, and to split these two sectors into three index sectors. In this method no index sector will contain less than 2/3 of the total possible number of keys, or 42 in our example. Thus the least number of records accessed with two levels of index would be 42*63 or over 2600. Depending on storage space and program logic this scheme could, of course, be carried even further by looking at the next two index sectors, etc.

There is one factor which should be taken into account when a new file is created. If the records which make up the file are already in key sequence, then each new record to be added will have a key value which is larger than any key value already in the file. If no special precautions are taken, then each record will occupy a single sector, and the data portion of the file will be inefficiently utilized, with only 50% being used. To avoid this there are at least three possibilities. The first is to have a special program to load the file the first time. This program can then fill the data sectors to any desired percentage. If more than two data records can be fitted in a sector, and additions to the file are common, then it could be an advantage to leave room in each sector for one or more new records.

The disadvantage of a special program for loading the file is that the same situation can arise during normal processing, namely that records in key sequence are added to the end of the file. The second method is to treat an addition of a higher record key as a special case, and try to insert it in the data sector containing the current highest key value. This method can be used both for new files and for additions to an existing file.

The third possibility, which can have other advantages, is to keep the index and the data in two separate files or distinct portions of the same file. This would mean storing all keys and pointers in the index at the lowest index level. The data records would not be stored in any particular sequence, but a new data record would be inserted at the first available point in the data file. This would mean that all available space would be utilized in the data file, but at the cost of extra keys and pointers in the index file. In our example with only two data records in each sector the extra indexes would probably be justifiable.

One advantage to be gained by having the data and index separate is that the file can be created with as many different indices as required. A customer name and address file could be indexed by customer number and by zip code, an employee file by employee number, social security number and first letters of the surname, etc. This

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BEGINNER'S CORNER

Spencer Koenig

The Meeting of Parallel Lines

In my last article I gave you a list of texts that I thought should be on every beginner's (and in some cases every intermediate's) bookshelf. To write that article, I found myself sifting through my whole collection trying to find those books that were self sufficient and that contained the best explanations on a given topic. As you saw, the topics ranged from introductions into what computers were (are) and how to use them, up to esoteric subjects covering the BASIC interpreter and how it functioned.

In that discussion, I could easily have included other areas that have, over the years, interested me. For example, the topic of languages is well covered in *my* bookshelf. Consider the language of PASCAL, for example. I have at least six books on the subject. I have two on LISP and three on FORTRAN. You might say that I was indulging in overkill. (What gives you that idea?)

The topic I want to get to is called *parallel reading*. What this means, if you haven't already figured it out, is that you read several books at one time on one subject. I came across the term several years ago, although I had been practicing it for quite a few years before. By the way, if any of you happen to find the source for the term, please let me know, so that I can give credit where credit is due.

The idea stems from problems you find in any area. Sometimes, when an author is writing a text, he loses sight of whom he might be writing for, and he slips into a less clear style of writing. Or, in another case, an editorial oversight can occur, leaving certain concepts or characters badly or not at all explained. Problems like these stop short an inquiring mind (like yours and mine). So remember my golden rule: if you want to study a topic, get at least two different views (like your shrinks, for example) or texts on the subject. Any teacher will tell you that it pays to have several means of approaching a subject; it's always good to get a second opinion on anything.

As life would have it, I found myself in a situation where I had forgotten my own rule and suffered the price. I was visiting a friend who was performing at the Bach Aria Festival at Stony Brook on Long Island (did you know that Brooklyn is physically part of Long Island?). At that time I had an intense interest in LISP (LISt Processing). The reason for my interest was due to the fact that Microsoft had just come out with Mumath/Musimp, which is advertised as a superset of LISP. This meant that if you could program in LISP you could use Mumath as a LISP type interpreter on your TRS-80. It all sounded terrific and fascinating.

I quickly went out and purchased a book on the subject. The text, I must say, is really excellent and well written. The title is LISP. (Pretty good, huh?) The authors are Patrick Henry Winston and Berthold Klauss Paul Horn. The book is published by Addison Wesley (which seems to be the only publisher with only one first name).

I thought I was on my way. I was going to really get into it and practice understanding all the concepts and symbols, and maybe make a dent in understanding a little about the big subject of *artificial intelligence*. A friend of mine made an observation to me recently, that those involved in the subject are going about all wrong. He suggested that they should try to understand real intelligence before going on to the artificial kind. I didn't have the heart to break the news to him. I figured let sleeping minds lie. Besides, if you used my friend as an example, you might have a good argument to oppose his point of view.

At any rate, one weekend at the festival (which was really excellent), I had taken the text with me, and as my limited intelligence would have it, I came across a symbol I didn't recognize and couldn't seem to locate anywhere in the text prior to the section I was reading.

That has to be one of the most frustrating things. It could also have been an idea that I would have found hard to understand. Any way you look at it, the result is the same: you find your interest waning as your eyes glaze in your attempt to read on.

When I returned home I realized that the solution was to purchase a second text on LISP called *The Programmer's Guide to LISP* by Ken Tracton. The LISP book published by Addison Wesley cost $15.00 at the time, and I thought that was expensive. (Boy, how times change!) The Tracton text cost $5.95 and is really very good. The two books should not be compared. They are on totally different levels and seek to accomplish similar ends through very different means.

In the Winston text you find hundreds of test examples with answers in the back, as well as an appendix to another type of LISP dialect called INTERLISP. The text itself covered something called MACLISP. It seems that INTERLISP distinguishes upper and lower case among other things and MACLISP does not. There are also a number of other differences, but I won't go into them at this point.

The Tracton book is more superficial, as far as being compared to a classroom text, but it is easier to understand and easier to find your way through when searching for some specific term or symbol. If you are interested in the subject, I recommend both texts to you.

I realize that some people object to spending the extra money, but think about it this way: if you had spent the money on a text and found it either poor in writing style or unclear, or for some other reason just not interesting, and the result was that the text wound up sitting on your shelf, then you have wasted more than money, you have wasted your time as well.

That's the reason why you will often find that I recommend a number of texts on one subject. For example in my last article I recommended that three texts should be thought of as a set. They were *Intermediate Programming for the TRS-80 (Model I)* by David Heiserman, published by Howard Sams, Inc., *Programming Techniques for Level II BASIC by William Barden, Jr.* published by Radio Shack (who?), and *BASIC Faster and Better and Other Mysteries* by Lew Rosenfelder, published by IJG Inc.

These three texts are by far the best written and most

continued on page 47

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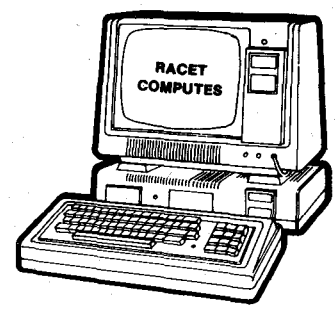

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GRID, MONOGRAM, and DO-IT-YOURSELF BRAIN SURGERY

Gordon Speer

GRID and the EPSON MX-80

Those of you who have not yet invested in a printer for your TRS-80 need wait no longer. I have been enjoying a little MX-80 for a couple of months now and think it is capable of doing any kind of printing you'll ever need, except color. I understand that color can be handled also by exchanging ribbons, and overprinting the same sheet, if necessary.

This little printer features type widths from 5 to 17 per inch, italics, subscripts, superscripts, underlines, and a super instruction book, etc. The narrow printing gives you as many columns on 8 ½ inch paper as the old IBM's get on 15 inches, and the graphics option allows you to design your own characters or even letterheads. You can even teach it to sign your name (all in little dots, of course).

But what about the GRID program. I have been using Apple, PET, and TRS-80 to teach BASIC, and sometimes need screen worksheets or graph paper for various purposes. Since the EPSON has such nice features I wrote a program to draw graph paper with any number of squares in both directions, and any size squares. Square sizes are in pica units which are tenths of an inch or quarters of a centimeter. Therefore one-inch squares are size 10, and centimeter squares are size 4. If you ask for more distance across the paper than the 8 inch printed line, the program asks you to input again.

I think this program will work with all EPSON printers, since it does not use the graphics option, but I can't guarantee it. If your CHR$(159) on your EPSON looks like a big plus sign, it will work.

```
100 'GRID        PRINTS GRAPH PAPER ON EPSON MX
110 CLS
120 CLEAR 1000
130 DEFSTR B,H,M,T,S
140 INPUT"NUMBER OF SQUARES ACROSS";A
150 INPUT"NUMBER OF SQUARES DOWN";D
160 INPUT"SIZE OF SQUARES";S%
170 LPRINT CHR$(27)"E";          'EMPHASIZED PRINTING
180 LPRINT CHR$(27)"A"CHR$(7); 'VERTICAL PAPER FEED SPACING
190 IF A*S% > 78 THEN 140        'OUT OF RANGE
200 HI=STRING$(S%-1,157)         'HORIZ INTERVAL
210 HS=STRING$(S%-1,32)          'HORIZ SPACE
220 FOR J=1 TO A-1               'COUNT THE SQUARES ACROSS
230 TR=TR+HI+CHR$(152)           'BUILD TOP ROW
240 SR=SR+HS+CHR$(156)           'BUILD SPACE ROW
250 MR=MR+HI+CHR$(159)           'BUILD MIDDLE ROW
260 BR=BR+HI+CHR$(158)           'BUILD BOTTOM ROW
270 NEXT J
280 TR=CHR$(134)+TR+HI+CHR$(149)
290 SR=CHR$(156)+SR+HS+CHR$(156)
300 MR=CHR$(150)+MR+HI+CHR$(151)
310 BR=CHR$(153)+BR+HI+CHR$(154)
320 LPRINT TR                    'TOP ROW
330 FOR L=1 TO D-1               'COUNT THE SQUARES DOWN
340 IF S%=1 THEN 380
350 FOR J=1 TO S%-1
360 LPRINT SR                    'SPACE ROW
370 NEXT J
380 LPRINT MR                    'MIDDLE ROW
390 NEXT L
400 IF S%=1 THEN 440
410 FOR J=1 TO S%-1
420 LPRINT SR
430 NEXT J
440 LPRINT BR                    'BOTTOM ROW
450 LPRINT
460 LPRINT CHR$(27)"@";          'CANCEL CODES
```

MONOGRAM

When you draw large block letters you can make them look like they are three-dimensional by adding a shadow below and to one side. How can you show a shadow on a black and white screen? Try this. First you paint the background with a checkerboard pattern. Then working from top to bottom you put the shadow over the checkerboard, and then the white letter. If you have an EPSON printer, use GRID to make a worksheet for the letter shape. The MONOGRAM program makes a letter S.

```
100 'MONOGRAM
110 CLS
120 CLEAR 1000
130 FOR N=1 TO 8                 'BACKGROUND
140 PRINT
150 PRINT STRING$(63,153)
160 PRINT STRING$(63,166);
170 NEXT N
180 DATA 76,40,140,40,204,8,236,8,268,8,332,8,396,40
190 DATA 460,40,556,8,620,8,684,8,716,8,748,8,780,40,844,40
200 FOR D=1 TO 15                'DATA FOR PATTERN
210 READ P,L                     'POSITION, LENGTH
220 PRINT @P+61,STRING$(L,128);'SHADOW - LOWER LEFT
230 PRINT @P,STRING$(L,191);     'LETTER S
240 NEXT D
250 GOTO 250                     'SCREEN LOCK - NO SCROLL
```

DO-IT-YOURSELF BRAIN SURGERY

This used to be a common joke a couple of decades ago. I think it was after "My sister married an Irishman. Oh, really? No, O'Reilly", and just before yo-yos. At any rate few of us ever seriously thought of becoming brain surgeons.

Years later when we spent all that cold cash for a computer we heeded the warnings not to open the protective case and look at the complex inner workings, for fear of voiding the warranty, or damaging some irreplaceable components. But now that the paint has worn off the front of the cases and our kids have spilled Pepsi and goodness knows what else inside, some of us are a bit less hesitant

continued on page 30

DO-IT-YOURSELF BRAIN SURGERY

continued from page 28

about sneaking a peek at the innards, and so I present here a narrative of my latest session in the operating room, hoping to offer some suggestions along the way for those of you who will also be doing surgery.

The patient was a Model-I keyboard which refused to correctly edit line 1320 in a program. Since the program is stored in RAM, I suspected a faulty RAM chip. A quick run of a memory test program showed a fault in the first 16K of RAM. I happened to have some RAM chips left over from an overhaul of another Model-I a few years ago. You may already know that your ROM (read only memory) is the BASIC interpreter which is contained on one or two large DIP (dual inline plug) devices under your keyboard, and the RAM (random access memory) consists of eight smaller DIP's in roughly the same area. It is the RAM which stores your screen contents, variable values, and program statements in areas which are described by a memory map you'll find in your manual. I suspect that each RAM chip stores one of the bits of each byte of data, since exchanging chips did not move the location of the error.

The operating room was prepared by placing a thick, folded towel on my desk under the fluorescent light, and making certain the humidity was high enough to prevent the static sparks which can be deadly to semiconducting devices. I have a natural spring that runs across my basement floor so keeping the humidity up is never a problem here.

The instruments were carefully laid out: a #2 Phillips screwdriver to open the case, a DIP remover tool fashioned from an old pair of tweezers by bending the tips in and grinding them thin and square, a pink pearl eraser for cleaning the legs of the RAM DIP's, and a glass of Pepsi (I can't operate without a drink in one hand).

The patient was turned upside down on the operating table and the warranty warning sticker was removed. It covered one of the 6 case mounting screws. All 6 screws were removed and the plastic residue in the threads of the screws was cleared away to allow as much bite as possible in the plastic case upon reinsertion. I noted that the screws were three different lengths, short toward the front ond long toward the back of the keyboard.

Gently lifting the bottom of the case away from the computer finally showed me all that technology I'd read about. I also noted 5 or 6 white spacers which would have to be put back in place before reassembly. Using the tweezers I removed one of the RAM chips and replaced it with a spare. (Some of you will recognize the following procedure as the one used on series strings of tree lights at Christmastime.) I then ran the memory test again to see if the problem had gone away. It hadn't. After cleaning the little metal feet of the RAM chip with the pink pearl eraser I exchanged it with the second RAM chip in the keyboard and ran the memory test again. To keep this narrative short I'll let you know it was #6 that was bad.

Two things to watch on reassembly are the spacers that keep the two circuit boards separated, and the little red idiot light (light emitting diode) that fits into a plastic grommet near the keyboard. Be careful and work slowly and you shouldn't have any trouble.

It probably would behoove all of us to keep some spare RAM chips on hand and know how to change them when necessary. It certainly is not a difficult procedure if you are careful, and the chips are only a couple of dollars apiece anyway. In closing let me recite two of Speer's maxims: (1) Before you take it to an expert, see if you can fix it yourself (even if you can't fix it you'll learn something). (2) If it ain't broke, don't fix it!

DISK DIRECTORIES

Do you know exactly what you have on each of your disks? If so you can skip this paragraph. I have been using TRS-DOS exclusively for several years, and writing the names of the programs on 4x5 cards which I keep in the disk envelopes, but I sometimes lost programs because I forgot to list them on the cards. One of the features of the DOS PLUS operating system is called FORCE. If you have (or borrow) a two-drive system, and put DOS-PLUS in the #0 drive, and type: FORCE *DO TO *PR and put your disks in drive #1, and type: DIR :1. You will get the nicest little printed directories on the line printer you ever saw. If the printer happens to act like my EPSON, the directories will be printed in condensed (narrow) type, and will fit in your diskette envelopes without folding. One extra suggestion; mark the number of each disk on the corresponding directory, so they don't get separated.

Gordon Speer
3304 Woodlawn Road
Sterling, IL 61081 ■

ARRAY OF HOPE FOR BASIC PROGRAMMERS

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would make fast searches on all the useful keys possible. The disadvantages are the extra processing time to insert new records, the extra disk space required for the indices, and the slightly more complicated sequential reading of the file.

The processing speed advantages of the B-tree compared to a binary tree should be obvious for files stored in external memory. The number of disk accesses can be reduced drastically, and hence the time required to find a particular record. The disadvantage is that more coding is required to implement a B-tree than a binary tree, and thus many users have probably tended to ignore B-trees as a file structure. The code required to implement a full update of a B-tree in Basic is quite extensive, and will not be given here, but it should not be beyond the capabilities of most programmers writing programs for the types of applications where B-trees are useful. I have also seen at least one advertisement for a data retrieval routine using B+ trees (probably a modified B-tree structure), although not for the TRS-80. The technique is also used by at least one major mainframe supplier for implementing indexed data files.

If there is enough interest amongst readers of this series, a program to search for and insert records in a B-tree will be given in a later installment.

continued on next page

5.4 Literature

This brings us to the end of our journey through search methods. For further reading there are a number of books available which go into more depth on the topics we have covered.

The Art of Computer Programming Vol 3: Sorting and Searching by Donald E. Knuth, published by Addison Wesley is one of the most thorough descriptions of searching methods. Unfortunately the algorithms are presented in a hypothetical assembly language called MIX instead of a better known high level language. This may discourage a number of potential readers, but the text can be read without having to read the programs.

Algorithms + Data Structures = Programs by Niklaus Wirth, published by Prentice-Hall covers sorting and searching techniques, with examples solved in Pascal. Since Wirth is the "father" of Pascal (not the person, the language) this seems a reasonable choice. For those interested in further information on B-trees it contains a 5-page program to perform searches, insertions and deletions in B-trees.

Information Representation and Manipulation in a Computer by E. S. Page and L. B. Wilson, published by Cambridge University Press, is a paperback covering the most important topics, except for B-trees, covered in this series. The algorithms are given both in plain text and as Algol procedures. Algol is similar to Pascal and should be readable even for those who have no experience in either Pascal or Algol.

An Introduction to Data Structures with Applications by J. P. Tremblay and P. G. Sorenson, published by McGraw-Hill is a large volume (about 700 pages) covering a large number of topics related to searching, sorting, and data structures. The book is obviously not aimed at microcomputers since the algorithms are written in PL/I, but since it was published in 1976 this is to be expected. B-trees are not mentioned, but the technique is used to illustrate an indexed sequential file management system. In the preface the authors list 5 features which are desirable in a language used for manipulating various data structures. Of these 5 Basic really only satisfies a single one, namely character strings of dynamically varying length. Fortran is mentioned as the antithesis of a language to be used, since it has none of the five features. Nevertheless

Introduction to Data Structures and Non-Numeric Computations by Peter C. Brillinger and Doron J. Cohen, published by Prentice-Hall, uses Fortran as the language for coding the algorithms. The book is older than any of the others mentioned above, and would probably only be of use to programmers using Fortran for their programs. B-trees are not mentioned at all, but most of the other structures presented earlier are covered.

Besides the above books which I have had access to, a large number of other books cover the same topics in more or less depth. Any attempt to cover them all would require at least as much space as the rest of this series.

(To be continued)

Arne Rohde
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7600 Struer, Denmark ■

ASSEMBLY LANGUAGE FOR BEGINNERS (PART 10)

Joseph Rosenman

Now that you have had a month to ponder the mysterious delay routine (presented as part of the final programming example in the last issue), it's time to study the trace.

```
 1 PC=5213 A=21 BC=0000 DE=4000 HL=3FFF SP=7100  CALL 521AH
 2 PC=521A A=21 BC=0000 DE=4000 HL=3FFF SP=70FE  PUSH AF
 3 PC=521B A=21 BC=0000 DE=4000 HL=3FFF SP=70FC  LD   HL,500H
 4 PC=521E A=21 BC=0000 DE=4000 HL=0500 SP=70FC  DEC  HL
 5 PC=521F A=21 BC=0000 DE=4000 HL=04FF SP=70FC  LD   A,H
 6 PC=5220 A=04 BC=0000 DE=4000 HL=04FF SP=70FC  OR   L
 7 PC=5221 A=04 BC=0000 DE=4000 HL=04FF SP=70FC  JR   NZ,521EH
 8 PC=521E A=04 BC=0000 DE=4000 HL=04FF SP=70FC  DEC  HL
 9 PC=521F A=04 BC=0000 DE=4000 HL=04FE SP=70FC  LD   A,H
10 PC=5220 A=04 BC=0000 DE=4000 HL=04FE SP=70FC  OR   L
11 PC=5221 A=04 BC=0000 DE=4000 HL=04FE SP=70FC  JR   NZ,521EH
12 PC=521E A=04 BC=0000 DE=4000 HL=04FE SP=70FC  DEC  HL
13 PC=521F A=04 BC=0000 DE=4000 HL=04FD SP=70FC  LD   A,H
14 PC=5220 A=04 BC=0000 DE=4000 HL=04FD SP=70FC  OR   L
15 PC=5221 A=04 BC=0000 DE=4000 HL=04FD SP=70FC  JR   NZ,521EH

16 PC=521E A=00 BC=0000 DE=4000 HL=0001 SP=70FC  DEC  HL
17 PC=521F A=00 BC=0000 DE=4000 HL=0000 SP=70FC  LD   A,H
18 PC=5220 A=00 BC=0000 DE=4000 HL=0000 SP=70FC  OR   L
19 PC=5221 A=00 BC=0000 DE=4000 HL=0000 SP=70FC  JR   NZ,521EH
20 PC=5223 A=00 BC=0000 DE=4000 HL=0000 SP=70FC  POP AF
21 PC=5224 A=21 BC=0000 DE=4000 HL=0000 SP=70FE  RET

22 PC=5216 A=21 BC=0000 DE=4000 HL=0000 SP=7010  JP   5202H
```

(1) "CALL" the subroutine from the main program. Notice that the SP is decremented by 2 after the CALL. This is correct since the return address was PUSHed onto the stack.

(2) Take the contents of the AF register pair, and put them the stack (decrement the SP by 2).

(3) Get the delay value.

(4) Delay value = Delay value minus 1.

(5) Get the MSB of the current delay value (in the A register).

(6) Logically OR the A register (the MSB) with the L register (the LSB). If any bit in either the LSB or the MSB is not zero, the result will also be not zero.

(7) If the result is not zero, skip back to the DEC.

(8) Delay value = delay value minus 1.

(9) Get the MSB in the A register.

(10) OR the MSB with the LSB (A with L).

(11) Skip back if not zero.

(12) DEC value.

(13) Get MSB.

(14) OR MSB with LSB.

(15) Skip back if not zero.

This continues until the number in HL decrements down to 0001H. At this point, lets pick up the program trace.

(16) DEC value (it now equals zero).

(17) Get MSB.

(18) OR MSB with LSB (since both are zero, the result is 0).

(19) Don't skip back since the result is 0, just continue.

(20) POP the stack to get the contents of AF back. Note that the POP causes the SP to increment by 2.

(21) POP the address off the stack, and place into the PC register. This causes execution to continue with the instruction immediately following the CALL.

Well, that wasn't so bad. If we traced the delay routine instruction by instruction, we would have required quite a few lines. In fact, the formula to determine the delay line count is: 4 + 4 * DELVAL. If DELVAL is 500H (1280), then the formula is 4 + 4 * 1280 = 5214. Why 4 + 4 * X? The two first and last statements in the DELAY subroutine are only executed once. The middle four statements are executed once for each pass through the loop. If the delay value is 500H (1280), then we multiply the delay count by 4. When we use a delay value of 5000H (20480), the result is 81924. That's all fine, but how long does it take? Refer back to the Z-80 reference chart.

```
Label   Command Argument        Comment
DELAY   PUSH    AF              ;6.22/5.50 mcs
        LD      HL,500H         ;5.65/5.00 mcs
DEL1    DEC     HL              ;3.96/3.00 mcs
        LD      A,H             ;2.26/2.00 mcs
        OR      L               ;2.26/2.00 mcs
        JR      NZ,DEL1         ;6.78/6.00 mcs
        POP     AF              ;5.65/5.00 mcs
        RET                     ;5.65/5.00 mcs

        Model 1 timing:
6.22 + 5.65 + 5.65 + 5.65 = 23.17 mcs
(3.96 + 2.26 + 2.26 + 6.78) * 1280 =
15.26 * 1280 = 19532.8 mcs = 19.5328 milliseconds

        Model 3 timing:
5.50 + 5.00 + 5.00 + 5.00 = 20.50 mcs
(3.00 + 2.00 + 2.00 + 6.00) * 1280 =
13.00 * 1280 = 16640.0 mcs = 16.64 milliseconds

What about the 5000H (20480) delay value?
Model 1: 15.26 * 20480 = 312524.8 mcs = 312.5248 milliseconds
Model 3: 13.00 * 20480 = 266240.0 mcs = 266.2400 milliseconds
```

What are the important points to be gained from the character display program?

(1) The Video display can be profoundly effected by programs.

(2) Machine language is FAST!

(3) The CALL instruction isn't hard to understand.

(4) LDIR is a very powerful and useful instruction.

(5) PUSH and POP can be used to save register values.

PUSH and POP can also be used to transfer a value from one double register to another. Since I just mentioned transferring values from one register to another, I should

mention that there is a special instruction that can "swap" the HL and DE registers, the EX. Observe:

```
Label   Command Argument
        ORG     7000H
        LD      SP,7800H
        LD      HL,1234H
        LD      BC,5678H
        LD      DE,9ABCH
        LD      A,DEH

        PUSH    HL
        PUSH    BC
        POP     HL
        PUSH    DE
        POP     BC
        POP     DE
        EX      DE,HL
        PUSH    DE
        POP     AF
        EX      DE,HL
```

```
PC=7000 A=?? BC=???? DE=???? HL=???? SP=????  LD  SP,7080H
PC=7003 A=?? BC=???? DE=???? HL=???? SP=7080  LD  HL,1234H
PC=7006 A=?? BC=???? DE=???? HL=1234 SP=7080  LD  BC,5678H
PC=7009 A=.. BC=5678 DE=..?? HL=1234 SP=7080  LD  DE,9ABCH
PC=700C A= . BC=5678 DE=9ABC HL=1234 SP=7080  LD   A,DEH
PC=700F A=DE BC=5678 DE=9ABC HL=1234 SP=7080  PUSH HL
PC=7010 A=DE BC=5678 DE=9ABC HL=1234 SP=707E  PUSH BC
PC=7011 A=DE BC=5678 DE=9ABC HL=1234 SP=707C  POP  HL
PC=7012 A=DE BC=5678 DE=9ABC HL=5678 SP=707E  PUSH DE
PC=7013 A=DE BC=5678 DE=9ABC HL=5678 SP=707C  POP  BC
PC=7014 A=DE BC=9ABC DE=9ABC HL=5678 SP=707E  POP  DE
PC=7015 A=DE BC=9ABC DE=1234 HL=5678 SP=7080  EX  DE,HL
PC=7016 A=DE BC=9ABC DE=5678 HL=1234 SP=7080  PUSH DE
PC=7017 A=DE BC=9ABC DE=5678 HL=1234 SP=707E  POP  AF
PC=7018 A=56 BC=9ABC DE=5678 HL=1234 SP=7080  EX  DE,HL
PC=7019 A=56 BC=9ABC DE=1234 HL=5678 SP=7080  ???
```

Notice that the EX DE,HL will swap the contents of the HL and DE registers (you can't swap either HL or DE with BC). To transfer 16 bit values to and from the BC register (that is, to duplicate any register), you must PUSH the source, then POP into the destination. How could you swap HL and BC?

```
Label   Command Argument
        PUSH    HL
        PUSH    BC
        POP     HL
        POP     BC
```

If you were to enter a subroutine in which you had to "save" all of the registers, you might:

```
Label   Command Argument
SUB1    PUSH    AF
        PUSH    BC
        PUSH    DE
        PUSH    HL
       <whatever>
        POP     HL
        POP     DE
        POP     BC
        POP     AF
        RET
```

continued on page 39

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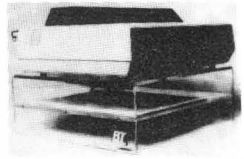

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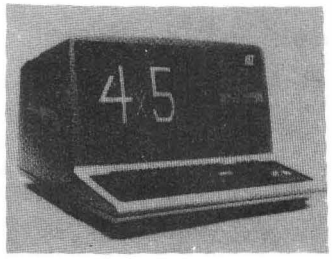

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POCKET COMPUTER CORNER

A SET OF BINOMIAL DISTRIBUTION ROUTINES

S. M. Zimmerman and L. M. Conrad

This set of four routines in one program on the PC1 from Radio Shack or PC1211 from Sharp allows the user to calculate the binomial probability, the cumulative binomial probability, the operating characteristic curve for the binomial distribution, and the average outgoing quality for the binomial. The program operates from a master menu from which the user selects the routine needed.

In all cases the output is a table from which a graph may be drawn with ease. The programs should be of maximum value to quality control managers and engineers who are responsible for the selection of attribute sampling plans which use the binomial distribution as its base. Industrial purchasing agents and sales personnel will also find the program will help them understand the sampling plans they use in the buying and selling of industrial goods and goods for the U.S. government.

The four routines in the program are:

IND-used to calculate the individual probabilities of a specific event.
SUM-used to calculate the cumulative probabilities.
OC -used to calculate the operating characteristic curve for a sampling plan
AOQ-used to calculate the average outgoing quality curve for a sampling plan

THEORY and Some Program Notes

The binomial equation is:

$$C_x^n \; p^x \; (1-p)^{(n-x)}$$

Where:

C= n! / (x! * (n-x)!) Combination of n things taken x at a time.
P= the probability of the event of interest.
n= the sample size.
x= the occurance of the event of interest.
n!= n * (n-1) * (n-2) ... 1
Ø!= 1

This equation is used for all four routines in our program. The subroutine in lines 11 and 12 calculates the factorials needed. Note:The largest number your pocket computer can handle is 69! (69 factorial = 69 * 68 * ... * 1) which places an upper limit on the capabilities of the program.

The subroutine in lines 12 and 13 calculate the binomial value and sum to be used by all the routines.

Running the Program

Typing R. and hitting the ENTER key in the DEFinable or RUN modes results in the main menu being shown on the display:

SUM IND OC AOQ?

You must type in your selection exactly as shown in the menu. If you enter anything else you will simply be returned to the main menu. Let's select the alternatives in order to examine the result. Type SUM and hit ENTER. The next thing you will see is a question asking for the sample size being used. (As noted in the theory section you are limited to a maximum value of 69).

SAMPLE SIZE?

The larger the sample size the more time is needed for our demonstration. We selected 10 because most binomial tables will give you the result for this sample size, which means you can check the program results against the tables. Type 10 and hit ENTER.

If you have a printer hooked up and running the results will now be printed. If not, you will see the results on the display. Those without printers will have to hit the ENTER key to make the computer continue in all cases. The routines are all designed to produce tables which are best printed on a printer. We will assume you either have a printer or know you must hit ENTER to make you computer continue when results are displayed and not speak of this again.

The results produced are:

SAMPLE SIZE 10.

The objective of printing all the input data as well as the output information is so the question may be matched with the answer for future reference.

The next question is:

P?

To answer this question you must input the value of the probability of occurence of the event of interest. If you are working with 10% defective material you type in 10. If you are working with a 1.5% occurence of the number of persons with blood type X in a given group, you type in 1.5. For our example assume we are working with 5% defective material. Type 5 and hit ENTER.

The computer now prints:

```
P% 5.
SUM              This is the type of chart being produced
X     P(X)       This is the title of the columns produced
```

and asks the following question:

X MIM MAX INC?

The value of X, the occurence of the event in the sample of 10, may vary from 0 to 10. You may wish to print all the results or some subset. If you wish to see all the results you input 0 and hit ENTER, then 10 and hit ENTER, and then 1

and hit ENTER. After completing this, the computer will produce the following results:

```
0. 0.59873
1. 0.91386
2. 0.98849
3. 0.99897
4. 0.99993
5. 0.99999
6. 0.99999
7. 0.99999
8. 1.00000
9. 1.00000
10. 1.00000
```

When complete the computer will return to the main menu. Check the above results against a binomial table and see how the close the results are. Our results matched most tables we checked with some minor round-off error which is normal in this type of work. If your table matched the first number exactly and not the second (for X=1) examine your second value. If it is equal to .31512, your table is designed to produce individual results not cumulative as is our first routine. Run IND for the same values of N, P, and the Xs and you will obtain the following:

```
SAMPLE SIZE 10.
P% 5.
X   P(X)
0. 0.59873
1. 0.31512
2. 0.07463
3. 0.01047
4. 0.00096
5. 0.00000
6. 0.00000
7. 0.00000
8. 0.00000
9. 0.00000
10. 0.00000
```

Again check these results against the proper type of binomial table.

The next two options are for the quality control person. You will be able to find tables or examples to check our results in the many quality control books which are available.

An operating characteristic curve is a conditional probability plot of the probability of acceptance of a lot of material based on a sampling plan, given the lot is of some specified quality. For low percent defectives in the lot, the probability of acceptance of the lot for any given plan is very high. As the percentage of defectives increases, the probability of acceptance decreases. Pur results demonstrate this idea.

Starting in the main menu select OC, a sample size of 10, an acceptance number (X in our program) of 2, a minimum P of 0, to a maximum of 50 in steps of 5 and you obtain the following results:

```
SAMPLE SIZE 1Ø.
X 2.          This is C the acceptance number.
OC
P%   OC %     The headings have changed.
Ø.   1ØØ.ØØØØØ
5.    98.84964
1Ø.    92.98Ø91
15.    82.Ø1964
2Ø.    67.77995
25.    52.55928
3Ø.    38.27827
35.    26.16Ø73
4Ø.    16.72897
45.     9.95596
5Ø.     5.46875
```

The probability of acceptance is OC %, the percent defective is P %. As P % increases, the probability of acceptance decreases. This is typical of operating characteristic curves.

The last option in the menu is AOQ standing for average outgoing quality. The AOQ is a measure of the quality leaving as a function of the quality coming in. The assumption is, if a lot is rejected it is subjected to 100% inspection and all defective pieces are removed. The input questions are identical to the operating characteristic curve option. For a sample of size 10 with an acceptance number of 2 for percent defectives varying from 0 to 50% in steps of 5% the results are:

```
SAMPLE SIZE 1Ø.
X 2.
AOQ
P%   AOQ %    in this case AOQ % is assumed to stand for
Ø.     Ø.ØØØØØ  out going quality
5.     4.94248
1Ø.     9.298Ø9
15.    12.3Ø294
2Ø.    13.55599
25.    13.13982
3Ø.    11.48348
35.     9.15625
4Ø.     6.69159
45.     4.48Ø18
5Ø.     2.73437
```

An examination of AOQ %, the outgoing quality, indicates that one value 13.55599% is greater than all other values. Within the limits of the accuracy of our analysis it may be said that 13.55599% is the average outgoing quality limit.

EXAMINING THE PROGRAM

The first part of the program consists of the menu and lines which direct the flow of the program depending of the selected made from the menu. This section starts in line 1 and continues through line 6. Specifically line 1 is the menu while lines 2, 3, 4, and 5 direct the program flow to other parts of the program. Line 6 is a safety factor just in case the user selects an option not available in the program.

Lines 10 and 11 are a subroutine which calculates the factorial of a number. In lines 12 and 13 is the subroutine which completes the calculation of the value of a single binomial factor.

Lines 15 through 19 are a collection of subroutines which read the data into the program. In line 15 the sample size is read in. In line 16 the minimum, maximum, and increment value of X is read in for the binomial distribution. In line 17 the minimum, maximum, and increment value of P is read in for the OC and AOQ curves. In line 18 the value of X is read in for all curves, and in line 19 the value of P is read in for the binomial curves.

Starting in line 30 and runing through line 36 is the routine which produces both the OC, operating characteristic curve and the AOQ, average outgoing quality curve. This series of statements uses the earlier noted subroutines for all its input and most calculations.

Lines 40 thorugh 43 are used to calculate the binomial and sum of the binomial distributions.

PROGRAM LISTING:

```
1:USING :INPUT "SUM IND OC AOQ?";E$:S=Ø
2:IF E$="SUM" THEN 4Ø
3:IF E$="OC" THEN 3Ø
4:IF E$="IND" THEN 4Ø
5:IF E$="AOQ" THEN 3Ø
6:GOTO 1
1Ø:F=1:IF Z<=1 RETURN
11:FOR I=1 TO Z:F=F*I:NEXT I:RETURN
12:Z=X:GOSUB 1Ø:B=F:Z=N:GOSUB 1Ø:A=F:Z=N-X:GOSUB 1Ø:C-F:
   Z=(A/(C*B))*P↑X*(1-P)↑(N-X)
13:S=S+Z:RETURN
15:INPUT "SAMPLE SIZE?";N:PRINT "SAMPLE SIZE ";N:RETURN
16:INPUT "X MIN MAX INC?";L,H,J:RETURN
17:INPUT "P MIN MAX INC?";L,H,J:RETURN
18:INPUT "X?";X:PRINT "X ";X:RETURN
19:INPUT P?";P:PRINT "P% ";P:P=.Ø1P:RETURN
3Ø:GOSUB 15:GOSUB 18:PRINT E$:PRINT "P% ";E$;" %":GOSUB 17
  :U=X:K=L
31:P=.Ø1K:IF P<=ØLET S=1:GOTO 33
32:FOR X=Ø TO U:GOSUB 12:NEXT X
33:IF E$="OC" LET S=1ØØS:PRINT K;" ";USING ####.#####";S:
   USING :S=Ø:GOTO 35
34:T=1ØØSP:PRINT K;" ";USING "####.######";T:USING :S=Ø
35:IF K+J>H THEN 1
36:K=K+J:GOTO 31
4Ø:GOSUB 15:GOSUB 19:PRINT E$:PRINT "X  P(X)"
41:GOSUB 16:FOR X=L TO H STEP J:GOSUB 12
42:IF E$="IND" PRINT X;" ";USING "##.#####";Z:USING :NEXT
    X: GOTO 1
43:IF E$="SUM" PRINT X;" ";USING "##.#####";S:USING :NEXT
   X:GOTO 1
```

SUMMARY

The routines included in this program are useful to those involved in quality control as an aid in the selection and use of acceptance sampling for attributes where the binomial distribution is the basis of the theory. The program allows for accurate and fast calculations of cumulative curves, individual curves, operating characteristic curves, and average outgoing quality curves.

The pocket computer is a useful tool for these calculations, especially since large microcomputers cannot be carried in one's pocket for such a task.

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ASSEMBLY LANGUAGE FOR BEGINNERS

continued from page 33

Important: note that the registers are POPed in the reverse order from which they were PUSHed.

I challenged you to re-write the display program so that the characters are displayed in reverse order. Here is the resulting code:

```
Label   Command Argument        Comment
        ORG     52ØØH
VIDEO   EQU     3CØØH   ;Start of Video RAM.
ENDVID  EQU     3FFFH   ;End of Video RAM.
DELVAL  EQU     Ø5ØØH   ;Delay value.
DOS     EQU     4Ø2DH   ;DOS re-entry location.
;
PROG5   LD      A,ØBFH          ;First character to save.
PROG5A  LD      HL,ENDVID       ;Last location in Video.
        LD      DE,ENDVID-1     ;Last-1 location in Video.
        LD      BC,4ØØH         ;Size of Video RAM.
        LD      (HL),A          ;Save character in Video.
        LDDR                    ;Fill rest of Video.
        CP      Ø2ØH            ;Last character?
        JP      Z,DOS           ;If done,exit.
        DEC     A               ;Next character.
        CALL    DELAY           ;Brief pause.
        JP      PROG5A          ;Repeat with next character.
;
DELAY   PUSH    AF              ;Save A register.
        LD      HL,DELVAL       ;Get delay value.
DEL1    DEC     HL              ;One less to count.
        LD      A,H             ;Get MSB of count.
        OR      L               ;Mash the MSB and LSB together.
        JR      NZ,DEL1         ;If both aren't Ø, repeat.
        POP     AF              ;Done, get A back.
        RET
;
        END     PROG5
```

```
52ØØ  3E BF 21 FF 3F 11 FE 3F Ø1 ØØ Ø4 77 ED B8 FE 2Ø
52ØØ  CA 2D 4Ø 3D CD 1A 52 C3 Ø2 52 F5 21 ØØ Ø5 2B 7C
52ØØ  B5 2Ø FB F1 C9 .. .. .. .. .. .. .. .. .. .. ..
```

This looks very similar to last issues program. There are two differences between the programs. In this program, we start with a LD A,BFH (the last character). Then, we DEC A and compare for 20H. In this way, the character appear in

reverse order. Needless to say, this change will be very apparent. The other change is also significant, but will not be visible. Video RAM will also be filled in reverse order (from the end to the beginning). It happens so quickly that it will look the same backwards or forwards. Why backwards? HL and DE point to the end of Video, and the instruction used is the LDDR (Load on Decrementing Register). I suggest you verify this fact by substituting a DELVAL of 5000H. Run at this speed, the Video will still appear "instantly" (even though the delay before the next character will be 16 times as great).

What next? Let's begin to develop a strange program - a word analysis program. What must the program do?

(1) Input a word from the keyboard (display while inputting)

(2) Count and display the characters

(3) Add up the numeric value of the word (why not)

(4) Display the characters in HEX

(5) Ask whether to quit or get a new word.

Of course, we won't be able to write the program this month. Instead, we can talk about some of the problems we will expect to encounter. How do we input a word from the keyboard? In this program, we will use one of the ROM subroutines. The subroutine will "get" the word from the keyboard, display it to the video, and place it into a special buffer (that we designate). Once the word is in the buffer, it is just "a bunch of numbers". So, it should be easy to add them up, right? Right! The problem is, how to we see the result? The answer is, by using another ROM subroutine. Is there a catch? You bet! After we add the characters up, we will have a "binary" number in a register. We have to change it to ASCII before we can display. Guess what: there is no ROM subroutine to perform this magic for us (get out your slide rule). Once we have mastered the art of converting HEX into ASCII, it should be easy to convert each digit into an ASCII character, then display it. Consider: we will read in an ASCII string, take each byte (2 HEX digits) and display as an ASCII character. So, if we were to input an "A" (where A equals 41H), we would display a "41". In order to get "a handle" on the problem of programming, we will separate each task into subroutines. In this way, we will create little "sub-programs" that could be used in other programs you might write.

Want to try something "completely different?" How about this: (1) Get a random number.

(2) If the number is not between 80H and 0BFH, get another random number.

(3) Fill the screen with that character (as in PROG4).

(4) Get two additional random numbers (any values).

(5) Use them as delay values in the delay subroutine.

OK, how am I supposed to do all of that? Easy. First, you should be able to determine whether or not a number is in between two other numbers (it takes two separate CPs). Then, plug it into PROG 4. To get a random number, we have to play a little trick. There is a register we haven't discussed yet, the R register. R stands for Refresh, and is used by the CPU to "keep memory accurate". The TRS-80 uses Dynamic memory (or DRAM). Dynamic memory must be "refreshed" periodically, or else it "forgets". The Z-80 refreshed memory in an invisible manner by using the R register (when it isn't accessing memory for any machine instruction). The R register is continuously incrementing from 0 to 255. Therefor, at any given instant, the R register will contain some byte. The only way to access the R register is with a LD to/from the accumulator. Thus:

```
Label   Command Argument
        LD      A,R     ;Get the current R value.
        LD      R,A     ;Set the current R value.
```

In our case, we want to get the current R value. How do we set a two byte variable delay? In the DELAY subroutine, you must:

(1) Get a Random number,

(2) Put in in H,

(3) Get another random number,

(4) save it in L.

HL now contains a 16 bit random number. Good luck. Next month, I will begin by presenting the "RANDOM SCREEN DISPLAY" program. Then, we will try our "WORD ANALYSIS PROGRAM". What better way to start the new year!

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Flushing, NY 11367 ■

PRACTICAL BUSINESS PROGRAMS

continued from page 20

```
48Ø CLS : PRINT " F(X)=";A;"+";B;"*  X  ": IF NO=-5 THEN
LPRINT" F(X)=";A;"+";B;"* X "
49Ø PRINT "ACTION MENU": INPUT "PLOT, FORECAST, NEW RUN,
OUTPUT MENU, END (P/F/N/O/E)";AA$: IF AA$="P" THEN INPUT
"REGRESSION LINE (1)F(X)= A+B*X,(2) NONE";H
5ØØ IF AA$="E" THEN END
51Ø IF AA$="O" THEN 21Ø
52Ø IF AA$="N" THEN 6Ø
53Ø IF AA$="P" AND H=1 THEN INPUT "LEVEL OF LIMITS 2,...3";L:
INPUT "CONFIDENCE INTERVAL OR PREDICTION LIMITS (C/P)";CP$
54Ø IF AA$="F" THEN 85Ø
55Ø INPUT "LOW POINT OR ORIGIN (L/O)";PL$: SX=BX: SY=BY: IF
PL$="O" THEN SX=Ø:SY=Ø
56Ø INPUT "HIGH POINT OR PROJECTION (H/P)";HP$: HX=TX: HY=TY:
IF HP$="P" THEN INPUT "PROJECTED X";HX: HY=A+B*HX: IF TY>HY
THEN HY=TY
57Ø CLS : FOR I=4 TO 43: SET(18,I): NEXT
58Ø FOR I=19 TO 125: SET(I,43): NEXT
59Ø I=7: FOR J=64 TO 832 STEP 128: I=I-1: PRINT @ J,
(SY+I*(HY-SY)/6);: NEXT
6ØØ I=-1: FOR J=97Ø TO 1Ø15 STEP 9: I=I+1: PRINT @ J,
(SX+I*(HX-SX)/5);: NEXT
61Ø FOR I=1 TO N:E=23+((X(I)-SX)/(HX-SX))*93: F=4Ø-
((F(I)-SY)/(HY-SY))*37: IF E>0 AND E<126 THEN IF F>0 AND F<46
THEN SET(E,F)
62Ø NEXT : IF H<8 THEN 66Ø
63Ø IF NO=-5 THEN 77Ø
64Ø PRINT @22,"PRESS ENTER TO CONTINUE";
65Ø Q$=INKEY$: IF Q$="" THEN 64Ø  ELSE 48Ø
66Ø IF H<>1 THEN 76Ø
67Ø J=Ø: S=(HX-SX)/1ØØ: FOR X=SX TO HX STEP S:
E=23+((X-SX)/(HX-SX))*93: F=4Ø-((B*X+A-SY)/(HY-SY))*37:
IF E>5 AND E<126 THEN IF F>0 AND F<45 THEN SET(E,F)
68Ø IF CP$="C" THEN 72Ø
```

```
69Ø IF J=Ø THEN J=1: GOTO 75Ø
7ØØ J=Ø: F=4Ø-((B*X+A+L*SE*SQR(1+1/N+((N*(X-XB)↑2)/ZX))-SY)
/(HY-SY))*37: IF E>5 AND E<126 THEN IF F>0 AND F<45 THEN SET(E,F)
71Ø F=4Ø-((B*X+A-L*SE*SQR(1+1/N+(N*(X-XB)↑2/ZX))-SY)
/(HY-SY))*37: IF E>5 AND E<126 THEN IF F>0 AND F<45 THEN
SET(E,F)
72Ø IF J=Ø THEN J=1: GOTO 75Ø
73Ø J=Ø: F=4Ø-((B*X+A+L*SE*SQR(1/N+((N*(X-XB)↑2)/ZX))-SY)
/(HY-SY))*37: IF E>5 AND E<126 THEN IF F>0 AND F<45 THEN SET(E,F)
74Ø F=4Ø-((B*X+A-L*SE*SQR(1/N+((N*(X-XB)↑2)/ZX))-SY)
/(HY-SY))*37: IF E>5 AND E<126 THEN IF F>0 AND F<45 THEN
SET(E,F)
75Ø NEXT
76Ø IF NO<>-5 THEN 64Ø
77Ø LPRINT " "
78Ø E$="###,###.###": FOR I=2 TO 43: J=42-I: IF I<43 THEN
LPRINT USING E$;(SY+J*(HY-SY)/39);:
79Ø FOR X=Ø TO 127 STEP 1.6
8ØØ IF POINT(X,I) THEN LPRINT "*"; ELSE LPRINT " ";
81Ø NEXT X: LPRINT " ": NEXT I
82Ø FOR I=Ø TO 6:G(I+1)=SX+I*(HX-SX)/5: NEXT
83Ø E$="          ###,###.###  ###,###.###  ###,###.###

E$;G(1),G(2),G(3),G(4),G(5),G(6)
84Ø LPRINT "SIGMA LIMITS USED ";L: GOTO 64Ø
85Ø PRINT "INPUT X & LIMIT,  F(X)=A+B*X  LOWER UPPER 9999
TO STOP";: INPUT X,L: IF X=9999 THEN 48Ø
LIMIT=";FB,"LOW PREDIT LIMIT=";FF,"UPPER PREDICT LIMIT=";FX
89Ø IF X<BX OR X>TX THEN PRINT "BEYOND DATA RANGE" ELSE PRINT
9ØØ IF NO=-5 THEN LPRINT"  X =";X,"F(X)=B+A*X=";F: LPRINT "LOW
CONF LIMIT=";FA;"UPPER CONF LIMIT=";FB: LPRINT "LOW PREDICT
LIMIT=";FF;"UPPER PREDICT LIMIT=";FX;
91Ø IF NO=-5 THEN IF X<BX OR X>TX THEN LPRINT "BEYOND DATA
RANGE" ELSE LPRINT " "
92Ø GOTO 85Ø
93Ø DATA 13,2949,1Ø,3106,6,4134,5,3959,8,3188,14,3Ø6Ø,17,2287,
14,2386,9999,9999
```

SUMMARY

Our program least squares linear regression analysis, with the addition of prediction and confidence limits, can make both an analytical and visual analysis. Our goal was to develop a program which could automatically calculate a least squares regression line, determine the prediction limits, and the confidence limits and then plot the picture of the results on either the TRS-80's cathode ray tube or printer.

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COLOR COMPUTER CORNER

Joseph Rosenman

This Month: EDTASM+ and ZBUG Monitor

Finally, a review of the Radio Shack EDTASM+ package for the Color Computer. First, the particulars:

Name:	EDTASM+
Cat #:	26-325Ø
Price:	$49.95
Format:	ROM Pack
Requires:	Any Color Computer.
Disk compatible:	Probably not.

This ROM pack includes three separate programs:
1) Editor,
2) Assembler,
3) ZBUG (monitor)

The Editor

The editor allows you to collect lines of assembly language text, and to edit or change these lines. EDTASM+ allows assembly source code (and assembled machine code) to be saved or read in from cassette tape. What commands are available from the editor?

A	Assemble: Assemble the source code.
C	Copy: Duplicate a section of source code.
D	Delete: Delete a line(s) from the source code.
E	Edit: Modify a portion of a single line.
H	Hard print: Print a range of lines to the line printer.
I	Insert: Insert a line(s) into the source code.
L	Load: Read in a source code file from the cassette.
N	Number: Renumber the source code.
P	Print: Display a range of lines to the CRT.
Q	Quit: Return to BASIC.
R	Replace: Replace a line(s) in the source code.
T	Type: Print a range of lines without numbers to the LP.
W	Write: Save a source code file to the cassette.
Z	ZBUG: Enter the machine language monitor.

All of the above commands are invoked by the single letter, usually followed by an argument (such as a range of lines, or a file to read or write). Each command has a short descriptive paragraph in the manual. In addition to being able to collect and edit assembly language source text, the EDITOR can collect BASIC source text (the editing commands are more powerful then those in BASIC).

Assembler

Assembly source code collected by the editor (or read in from cassette tape) is stored in the editor buffer. The assembler is invoked by the "A" command. (By the way, an Assembler is a program that converts assembly language source code into machine language. Each mnemonic in the assembly language source code is converted into a single machine language command.) Several options are available to control or modify the assembly process. Initially, there is a fundamental choice to be made: generate machine code to the cassette tape, or generate machine code in memory (where it can be examined or executed). To generate machine code on cassette, type: Any filename. The options available for assembly are:

/AO	
/IM	In memory: Generate machine code in memory.
/LP	Line Printer: Send listing to the line printer.
/MO	Manual origin: Allow the code to determine where it will be located.
/NO	No object: Don't generate object code.
/NS	No Symbol: Don't generate a symbol table.
/NL	No Listing: Just assemble, don't generate any listing.
/WE	Wait on Error: Whenever an error occurs in assembly, pause until an ENTER is hit.

Object code is another name for machine code. A symbol table is a listing of all of the symbols and labels used in the program (with their associated values). It is also possible to cause the assembly listing to pause by typing the shift-@ sequence (and continue by typing ENTER).

ZBUG

ZBUG is a monitor program that is connected to the Editor/Assembler program (the "+" in EDTASM+). ZBUG bridges the gap between assembly language source code and machine language. ZBUG will allow you to modify a program (previously assembled) in memory, execute it, single step it, etc. ZBUG will also allow you to save and load memory images (containing your program) to/from the cassette. The commands in ZBUG are:

B	Byte mode: Display all code as bytes.
C	Continue: Continue from a breakpoint.
D	Display: Display all of the breakpoints.
E	Edit: Return to edit mode.
G	Go: Execute (at the specified address).
H	Half-Symbolic: Display mnemonics as symbols, arguments as numbers.
I	Input mode: Determines the number base (radix) for input values (either Octal, Decimal, or Hexadecimal).
L	Load: Get a memory image from cassette tape.
M	Mnemonic mode: Display all code in disassembled format.
N	Numeric mode: Display all code as numbers.
O	Output mode: Determines the number base (radix) for output values.
P	Program: Saves a memory image to cassette tape.
R	Register: Display all register contents.
S	Symbolic: Display all code as symbols (opp. of numeric).
T	Type: Display a range of code/numbers.
TH	Type hard: Print a range of code on the LP.
U	Transfer: Move a block of code.
W	Word mode: Display values as 16 bit quantities.

X Breakpoint: Set a breakpoint at the specified address. There are 8 breakpoints available (Ø-7).

Y Yank: Remove a specific breakpoint.

/ Display: Display the code at address preceeding the /.

; modify argument: Used to modify only the argument of an assembly language statement.

ZBUG is a reasonably powerful monitor. One particularly nice feature of the EDTASM+ package is the fact that all three sections are available at the same time. You can collect a program, assemble it, test it, re-edit it, re-assemble it, re-test it, etc., without ever needing to reload it. WARNING: Running a program with bugs might scramble any (or all) of memory. If this happens, the Color Computer could "crash". If it crashes, your only recourse is to power down, wait for thirty seconds, then power up again. Anything you hadn't saved will, of course, be lost. You should note that this is a normal situation, and not due to a flaw in the design of the Color Computer. Whenever you work with assembly language, you run the risk of accidentally having the computer "do something terrible." The proper course of action is to save any significant changes in your source file. Since I'm on the subject, Radio Shack DID leave something off of the Color Computer. The reset button is a "soft" reset: it goes inside and tells its internal operating system to fix things up. This soft reset can't help when doing assembly language work, since you have completely taken control away from the OS. Therefor, we need a "hard" reset — which would force the machine to go from scratch. The only way to do this on the Color Computer is to power down - pause - power up. ZBUG will also allow numeric calculation, base conversion, logical operations, etc.

This EDTASM+ includes a 68 page reference manual. This manual is reasonably complete. In addition to describing the Editor, Assembler, and ZBUG, the manual includes information on interfacing with BASIC programs, and includes a 6809 machine mnemonic reference table. While the examples provided were pertinent, I felt that the reference manual would have benefitted from a more liberal distribution and ranges of examples and test programs.

Evaluation

On the whole, I found this to be a surprisingly good package. The program is more expensive then most Color Computer software packages, but I believe you are getting your money's worth in this case. If you are going to work with assembly language, I recommend that you get the 6809 Assembly Language Programming book reviewed in the last issue. Radio Shack mentions a book on 6809 Assembly Language programming by William Barden. I have been unable to find a copy to date, but I will review the book when it is available to me.

Presented below is a modified version of the first sample program presented in the EDTASM+ manual. This program uses the entire video display (rather then just the lower half), and fills the display with all of the displayable characters (not just 0F9). Note that the program includes a delay subroutine (to pause in between screens). You can increase or decrease the delay by adding or removing calls to the delay routine.

(See program listing on page 62.)

Note that the multiply in the WAIT subroutine is meaningless, it just wastes time.

It is with some regret that I must close this issue with a sad note. This will be the last regular column on the Color Computer that I will be writing. I will continue to prepare Color Computer "specials"from time to time. I also will be continuing to write other "specials"for Computronics. The time that I've had available for this column has been seriously limited by ever increasing responsibilities. So, good luck to all of you Color Computer users!

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CHANGE BAUD RATES ON SYSTEM TAPES

(Model III Only)

Kenneth R. Meyer

We Model III users are easily spoiled by the fast CLOADs that the 1500 baud gives us. The first thing we do when we get a new program is quickly rerecord it at the higher rate — except when it is a SYSTEM tape. Oh how frustrating it is to load a SYSTEM tape and watch those slowly blinking asterisks. This program will solve this problem (well — most of the time).

When you run this program it will prompt you to ready the tape that contains the SYSTEM program that you want to copy; after you hit ENTER this program will copy the SYSTEM program into memory. Then the program will prompt you to ready the (possibly different) tape where you want the system tape copied at the high baud rate. Be sure that you don't record over your original copy! Then the program will repeat the prompt to record so that you can make several backups.

There is one problem. Since both this program and the SYSTEM program much both be in memory at the same time, some very large SYSTEM programs cannot be copied on a 16K machine. The adventure program supplied with your subscription to *Computronics* is an example of such a large program. One way to help this problem without rushing out and buying more memory is to compress this program as you type it. I displayed the machine program so that each DATA statement corresponds to a single machine opcode or a logical group of opcodes for debugging reasons. You may place several numbers in one DATA statement. Just be sure that you keep the order corect and carefully proofread the data. The program given below is a simple BASIC driver program that creates two machine language subroutines using the POKE statement. The first subroutine is contained in the DATA statements 160 to 280, is POKEd into the array RE, and reads the SYSTEM program into memory. The second subroutine is contained in the DATA statements 290 to 395, is POKEd into the array WR, and writes the SYSTEM program to your tape. The SYSTEM program is copied into the space reserved for the array SP. When you are finished entering this program keep changing the dimension of SP until you get the largest array your machine will hold. (Do NOT change the dimensions of RE or WR).

```
100 CLS: DEFINT A-Z
105 A=0:B=0:C=0:D=0:OP=0:MS=0:LS=0:R$=" ":I=0:J=0:K=0:Z!=0
110 DIM RE(55),WR(55),SP(12900)
115 A=VARPTR(RE(0)): B=VARPTR(WR(0))
120 C=VARPTR(SP(0))
125 I=A
130 READ OP
135 IF OP=-1 THEN I=B: GOTO 130
140 IF OP=-2 THEN 405
145 POKE I,OP
150 I=I+1
155 GOTO 130
160 DATA 205,127,10             'CALL  0A7FH
165 DATA 6,120                  'LD    B,120
170 DATA 14,7                   'LD    C,7
175 DATA 205,150,2              'CALL  0296H
180 DATA 205,53,2,119,35        'CALL  0235H
                                'LD    (HL),A
                                'INC   HL
185 DATA 13                     'DEC   C
190 DATA 40,2                   'JR    Z,$+4
195 DATA 24,246                 'JR    $-8
200 DATA 205,53,2,119,35        'CALL  0235H
                                'LD    (HL),A
                                'INC   HL
205 DATA 184                    'CP    B
210 DATA 40,33                  'JR    Z,$+35
215 DATA 205,53,2,119,35        'CALL  0235H
                                'LD    (HL),A
                                'INC   HL
220 DATA 79                     'LD    C,A
225 DATA 205,53,2,119,35        'CALL  0235H
                                'LD    (HL),A
                                'INC   HL
230 DATA 205,53,2,119,35        'CALL  0235H
                                'LD    (HL),A
                                'INC   HL
235 DATA 205,53,2,119,35        'CALL  0235H
                                'LD    (HL),A
                                'INC   HL
240 DATA 13                     'DEC   C
245 DATA 40,2                   'JR    Z,$+4
250 DATA 24,246                 'JR    $-8
255 DATA 205,53,2,119,35        'CALL  0235H
                                'LD    (HL),A
                                'INC   HL
260 DATA 24,215                 'JR    $-39
265 DATA 205,53,2,119,35        'CALL  0235H
                                'LD    (HL),A
                                'INC   HL
270 DATA 205,53,2,119,35        'CALL  0235H
                                'LD    (HL),A
                                'INC   HL
275 DATA 205,248,1              'CALL  01F8H
280 DATA 195,154,10             'JP    0A9AH
285 DATA -1
290 DATA 205,127,10             'CALL  0A7FH
295 DATA 6,120                  'LD    B,120
300 DATA 14,7                   'LD    C,7
305 DATA 205,135,2              'CALL  0287H
310 DATA 126,205,100,2,35       'LD    A,(HL)
                                'CALL  0264H
                                'INC   HL
315 DATA 13                     'DEC   C
320 DATA 40,2                   'JR    Z,$+4
325 DATA 24,246                 'JR    $-8
330 DATA 126,205,100,2,35       'LD    A,(HL)
                                'CALL  0264H
                                'INC   HL
335 DATA 184                    'CP    B
```

```
340 DATA 40,33                  'JR   Z,$+35
345 DATA 126,205,100,2,35       'LD   A,(HL)
                                'CALL 0264H
                                'INC  HL
350 DATA 79                     'LD   C,A
355 DATA 126,205,100,2,35       'LD   A,(HL)
                                'CALL 0264H
                                'INC  HL
360 DATA 126,205,100,2,35,126,205,100,2,35
                                'LD   A,(HL)
                                'CALL 0264H
                                'INC  HL
                                'LD   A,(HL)
                                'CALL 0264H
                                'INC  HL
365 DATA 13,40,2,24,246         'DEC  C
                                'JR   Z,$+4
                                'JR   $-8
370 DATA 126,205,100,2,35       'LD   A,(HL)
                                'CALL 0264H
                                'INC  HL
375 DATA 40,215                 'JR   Z,$-39
380 DATA 126,205,100,2,35       'LD   A,(HL)
                                'CALL 0264H
                                'INC  HL
385 DATA 126,205,100,2,35       'LD   A,(HL)
                                'CALL 0264H
                                'INC  HL
390 DATA 205,248,1              'CALL 01F8H
395 DATA 201                    'RET
400 DATA -2
405 MS=A/256: POKE 16527,MS
410 LS=A-MS*256: POKE 16526,LS
415 INPUT "What baud rate is the old tape (H/L)";R$
420 IF R$<>"H" AND R$<>"L" THEN 415
425 IF R$="H" THEN POKE 16913,1: ELSE POKE 16913,0
430 PRINT "Position tape, press play, then press any key"
435 IF INKEY$="" THEN 435
440 D=USR(C)
445 D=D-1
450 IF D>0 THEN Z!=D-C+1 ELSE Z!=(65535+D)-C+1
455 PRINT: PRINT "File copied into memory"
460 PRINT "File name: ";
465 FOR I=C+1 TO C+6: PRINT CHR$(PEEK(I));: NEXT
470 PRINT: PRINT "Entry address:";256*PEEK(D)+PEEK(D-1)
475 PRINT "File length:";Z!
480 PRINT
485 MS=B/256: POKE 16527,MS
490 LS=B-256*MS: POKE 16526,LS
495 INPUT "What baud rate do you want for new copy (H/L)";R$
500 IF R$<>"H" AND R$<>"L" THEN 495
505 IF R$="H" THEN POKE 16913,1: ELSE POKE 16913,0
510 PRINT "Position tape, press record, then press any key"
515 IF INKEY$="" THEN 515
520 D=USR(C)
525 PRINT "File copied"
530 INPUT"Do you want to make another copy (Y/N)";R$
535 IF R$="Y" THEN 510  : ELSE IF R$<>"N" THEN 530
540 END
```

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INVISIBLE PASSWORDS FOR THE TRS-80

Jake Siepert and Brett Hobbs

In the 1930s, prohibition made the sale of alcoholic beverages illegal. To counter the problem, speakeasies, places where one could go to buy illegal drinks, began popping up all over America. The only problem was, in order to get inside the door of one of these establishments, you needed to know the password.

Now in the 1980s, microcomputers are flooding the market featuring a wide range of software, from business applications to personal fun and adventure. This presents a minor problem. How do you regulate the use of these various systems? The answer: Passwording. Now only those who know the password can run your programs.

Thanks to the article, "Unlistable Lines for the TRS-80" by Paul Tiernan, which appeared in the December 1981 issue of *Creative Computing*, the idea to password a program and then make the password unlistable came to be. (Note: this program is adapted to work with TRS-80 Level II, Models I and III).

For those of you who may have missed Paul's article, he outlines a way to generate invisible lines . . . let's review:

1. Type in the program line that you want to hide (the line must have fewer than 115 characters).
2. List the line you intend to make invisible, and check to see that it contains the correct information.
3. Count the number of characters in the line, including the line number and all spaces in the line.
4. Enter the edit mode by typing EDIT (line #) and pressing ENTER. Type X to display the entire line and move the cursor to the end of the line.
5. Type :REM, then type the same number of characters that you just counted in step 3, plus five more, adding to the end of the program line. These can be any characters, because they'll never be seen again — just be sure to count correctly.
6. Press the SHIFT and UP ARROW keys simultaneously.
7. Type the number corresponding to the number you counted in step 3, plus 5 (this number won't appear on screen as you type it), then press the backspace key. (Example: if you counted 31 characters and spaces in step 3, you type the number 36, then press backspace. This should place the cursor right behind the "M" in REM. If it doesn't, type X and go back to the beginning of this step.)
8. Again type the number you typed in step 7, then press the C key, but don't press ENTER yet!
9. Start pressing the backspace key, and keep pressing it until the cursor "wraps around" to the end of the preceding line (Note: wrapping the cursor up to the edge of the last line is an addition to the procedure described by Paul Tiernan. By doing this, you can eliminate a blank line of space when the program is listed on screen.)
10. Now press ENTER. You can run or list the program as much as you like, and you'll never see the hidden line.

Now let's take a look at a simple program and see how it can be passworded, then make the password statement disappear when the program is listed on the screen.

```
10 PRINT "THIS PROGRAM IS PASSWORDED"
20 PRINT "PASSWORD PLEASE"
30 INPUT A$
31 B$="HELLO"
40 IF A$=B$ THEN GOTO 60
50 IF A$<>B$ THEN GOTO 20
60 PRINT "GOOD WORK!"
```

The password, "HELLO", is assigned in line 31. Now if you were to enter this program and list it, the password would appear just as you entered it, since every line of the program is shown. Let's make line 31, the password instruction statement, unlistable.

1. List line 31. You'll find there are 13 characters and spaces, so add five to 13 for a total of 18.
2. Type EDIT 31 and press ENTER. You are now in the edit mode, so press X to list the line and get the cursor to the end of the line.
3. Type :REM123456789012345678
4. Press the SHIFT and UP ARROW keys simultaneously.
5. Type the number 18 and press the backspace key once.
6. Type the number 18 again followed by the letter C.
7. Press the backspace key until the cursor wraps around to the end of the preceding line.
8. Press ENTER and LIST the program.

Your listing on the screen will now display everything except line 31, which contains the password statement. Type RUN and test your program, and you'll find that without entering the password assigned in line 31, the program will not run. You have just gained control of your programs, and can regulate their use.

As with any system, there are ways to beat the game. If your TRS-80 has a printer you can list the program and all the lines will appear on the printout, because the printer cannot erase over itself. There is also the remote possibility that someone might guess the line number of your hidden line and use the EDIT mode to reveal that line. This merely means you have to be a bit more selective as to how you password your program. If you want, you can make the entire password sequence unlistable. The following is an example of how that can be done:

```
1 PRINT "PASSWORD PLEASE"
2 INPUT Z$
3 X$="HELLO"
4 IF Z$=X$ THEN GOTO 10
5 IF Z$<>X$ THEN GOTO 1
10 PRINT "HELLO, WHAT IS YOUR NAME?"
20 INPUT A$
30 PRINT "WHERE DO YOU LIVE?"
40 INPUT B$
50 PRINT "IT'S VERY GOOD TO MEET YOU,"
60 PRINT A$;"FROM";B$
70 PRINT "GOOD WORK, YOU BROKE THE PASSWORD!"
```

Now, using the instructions given above, make lines 1 through 5 of this program unlistable, then list the program. When the program is displayed on the screen, only lines 10 through 70 will be shown. Lines 1 through 5 will appear for an instant, but they are erased so quickly that the

unsuspecting will never notice. If you want to make the password sequence even more difficult to find, don't program it on consecutive lines. Hide the passwording throughout the program on any unused address lines.

As you can see (or maybe we should say as you *can't* see) the invisible password and its uses are as extensive as you want them to be.

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BEGINNER'S CORNER

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interesting of any I've come across. Each explains something about basic that the other left out or described poorly. For example, the Heiserman text doesn't discuss much on string packing. (For you beginners, this is a means of putting graphic characters into a string variable. The purpose is to allow for fast graphics.) Barden points out that the fastest subroutine for graphics involves using the PRINT routine. If you poke the graphic characters into a string and then PRINT the string variable, you can approach machine language smoothness in animation. The best examples of the use of this technique is in the work of Leo Christopherson, who, I believe, discovered the technique itself.

Since my discussion of these books, there is one more text I would recommend. (Do you believe this guy?) My reason for recommending it is that it covers a topic that the others don't cover. They each talk about machine code and basic programming techniques for the TRS-80 Level II machine, but none of them discuss the differences between the Model I and the Model III. The basic techniques may be universal. However, if you want to do some fancy work, there are times when you should be careful where you POKE around.

The text is called *Fast BASIC: Beyond TRS-80 BASIC* by George and Thomas Gratzer. Like the Rosenfelder book, there is a program disk available (I haven't gotten it yet) that contains a BASIC monitor that allows you to watch your machine do its thing. The text also points out the differences in specific ROM locations that you might want to use in your transition from BASIC programmer to machine language *and* BASIC programmer.

I don't think that this text is perfect. I find some of the explanations too short and often feel as if they were not as complete as they could have been. That's why I'm glad that having other texts on similar subjects is possible and not all that expensive.

It's unfortunate that no one has written the perfect text on the BASIC ROM or on BASIC for the TRS-80 for all the Radio Shack machines. In the same way, no one has written the perfect text for those in the middle of programmer growing pains, that is, between BASIC and

continued on page 60

PERT — A PLANNING AND CONTROL TECHNIQUE

C. Brian Honess

PERT (Program Evaluation and Review Technique) was created in the late 1950s, during the development of the Polaris Ballistic Missile, by the management consulting firm of Booz, Allen and Hamilton. As a planning, communication, control and reporting tool, PERT has been credited with bringing the Polaris to combat readiness over two years ahead of the original schedule. Several offshoots and variations of PERT have evolved, including LESS, PACT, RAMPS, and PERT/COST. CPM (Critical Path Method) is another similar planning and control tool.

The PERT Network

After the objective of a project has been clearly specified, a PERT "network" can be drawn. The network is a pictorial representation of all the interrelationships of activities and events that comprise a project. The value of having a network is clear, when other methods of scheduling and planning are examined. For example, one of the widely-used graphic display scheduling techniques is the Gantt Chart, which usually has a time scale running along the horizontal axis, with the rows of the chart representing machines, departments, or some other division of the facilities which are necessary to do the job. The Gantt Chart can reveal whether sufficient resources and capacity are available to handle the work load and help determine whether the work load is equally distributed among departments or machines. However, the Gantt Chart must be continually updated by hand; and jobs often must be rescheduled without the interrelationships among them being readily apparent.

Although it provides information on interrelationships among activities, the PERT network has not replaced the Gantt Chart. In fact, it is common in many cases to transcribe PERT Information into a Gantt-type of display chart. This is usually done for the benefit of people who are not familiar with network displays or with the format of the computer output of a PERT program. Since PERT deals only with the time constraint and does not consider such other constraints as quality or quantity, it is understandable that PERT should be integrated with other methods of control and planning, which consider these other constraints.

In addition to providing a pictorial delineation of the interrelationships of activities making up a project, PERT provides a method for getting timely and continuous progress reports, which can help identify potential problem areas where remedial action may be required. It is also possible to use PERT for the simulation of the effects of various alternative decisions which may be under consideration. This allows management to study the effect of alternatives upon program deadlines. The availability of computers to process PERT networks facilitates such study. In addition, PERT supplies estimates of the probability of successfully meeting deadlines. The larger and more complex projects are, the greater are the benefits likely to result from PERT. In summation, PERT can be a useful tool in allowing management to organize existing data into a more meaningful form for immediate use.

It is obvious that networks can be drawn for a project in varying degrees of detail. For this reason, a "skeleton network" is usually drawn first. The skeleton network displays the overall logic of the project and serves as a basis upon which to expand into greater detail. On the first try, it would be extremely difficult to draw a detailed network for a complex project like building a computer. A skeleton network can contain events that would later be expanded into many hundreds of events, and the overall logic of the project could be displayed.

In PERT, an "event" is defined as being a specific instant of time, either the start or the completion of a task, while an "activity" is the work that is required to accomplish an event. In the PERT network, an event is represented by an ellipse, and an activity is represented by an arrow. The computer program being used will specify the way in which events and activities are to be numbered, and various rules and methods for the formulation of the basic network will prevail. It is common practice in PERT to work backwards through the network, since it is usually easier to think of the work that precedes an activity than it is to think of the work that follows a particular activity. It has also been found that it is easier to work backward along a path that involves physical activities, such as installing, making, or finishing an object, and then to add the more abstract activities like designing, ordering, and training.

There are several ground rules for handling the events and activities in a network. Each activity must have a predecessor and successor event; no activity may start until its predecessor event is completed; and no given event can be followed by a path of activities which leads back to that same event, i.e., no looping. A short description is placed in each event ellipse, together with a "C" or an "S", depending upon whether "Completed" or "Start" applies to the event. Figure 1illustrates a section of a PERT network, showing several events and activities involved in fabrication, wiring and assembly of a product "Q".

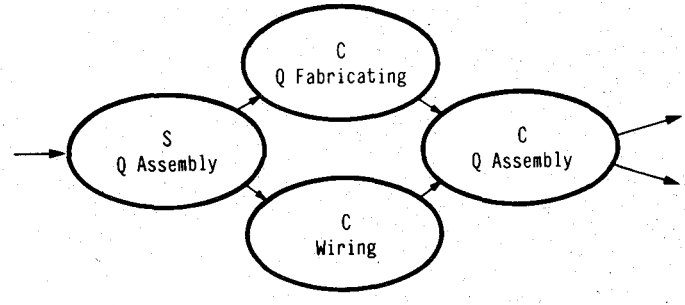

Fig. 1

After completion of the drawing of the network, time estimates are made for all of the activities. There are several rules which help you arrive at "unbiased" time estimates, and when these rules are followed, each activity yields a group of three time estimates:

1. t(o) (optimistic time) which is the length of time

required if no complications or unforeseen difficulties arise.

2. t(m) (most likely time) which takes into consideration normal circumstances and some allowance for some unforeseen delays.

3. t(p) (pessimistic time) which is the length of time required if unusual complications or unforeseen difficulties.

One of the rules PERT users sometimes use assigns a rule-of-thumb probability to both t(o) and t(p) such that there is only one chance in 100 that the activity can be accomplished in less than t(o) and one chance in 100 that the activity will take longer than t(p). Symbolically, $p(T + t(o)) = 0.01$ and $p(T - t(p)) = 0.01$.

The three lengths of time thus obtained are entered on the network drawing in the particular units of time being employed (hours, days, weeks, etc.), as in Figure 2.

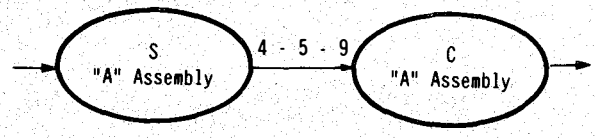

Fig. 2

There is one time estimate which must be calculated, and this is the "expected time" (or "average time") symbolized by t(a). The expected time is a weighted average of the optimistic time, the most likely time, and the pessimistic time, and is customarily calculated using the following formula:

$$t(a) = \frac{t(o) + 4t(m) + t(p)}{6}$$

The t(a) time is placed under the corresponding activity arrow in the network (Fig. 3).

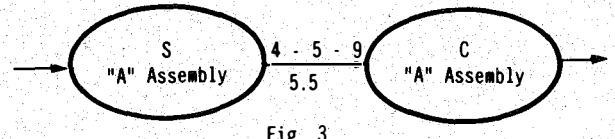

Fig. 3

We can diagram the various time figures as Figure 4, with the distribution being a "beta" distribution, and using example times, t(o), t(m), and t(p), or 4 - 5 - 9, and t(a) computed as:

$$t(a) = \frac{4 = (4 * 5) + 9}{6} = \frac{33}{6} = 5.5$$

Figure 4 indicates that the area under the curve is divided into two equal parts by the 5.5 t(a) line and therefore, that the probability is 0.5 that the activity will require more time than 5.5 and also 0.5 that the activity will not require more time than 5.5 units of time.

PERT Example

Suppose you've decided to install a new computer and software system in a room of your home or office. There is

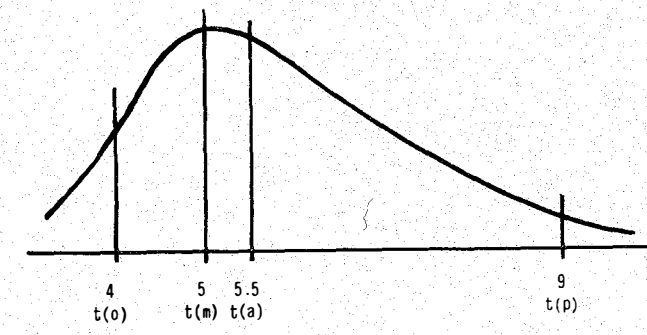

Fig. 4

currently some equipment there, which won't be used with the new system. The new system will require different supplies (paper, ribbons, diskettes, etc.) and will also require a phone line for off-premises data collection, and tie-in to another system. You prepare a listing of the tasks to be accomplished (in no particular order):

1. Purchase software package
2. Purchase supplies
3. Purchase hardware
4. Install hardware
5. Test hardware
6. Modify software package
7. Test system
8. Install new furnishings
9. Paint room
10. Install new phone equipment
11. Remove old system
12. Install new power system

The PERT network in its early stages may be diagrammed as in Figure 5.

(See Figure 5 on page 50.)

Figure 6 shows the network after the time estimates have been entered. Note also that the events have been replaced by numerical codes for easier handling in the computer program.

(See Figure 6 on page 50.)

Figure 6 also introduces two new concepts: (1) dummy activities and (2) the critical path. A dummy activity, like activity 130-140, represents no work expenditure. It is only inserted to help maintain the logic of the network. Since every event ellipse is identified as starting something or completing something, the network will be more easily understood if the starting point and completion point of an event can each be identified. Since the start of an activity which is not represented by a start ellipse is that point in time immediately following the completion of the predecessor event, it is often not necessary to show both of these instantaneous points in time. However, if the logic of the interrelationships, and the ease of understanding the network can be improved by the inclusion of dummy activities, such dummy activities will help avoid confusion and thereby show a truer description of the project tasks. In this case, the event numbered 130 (complete system

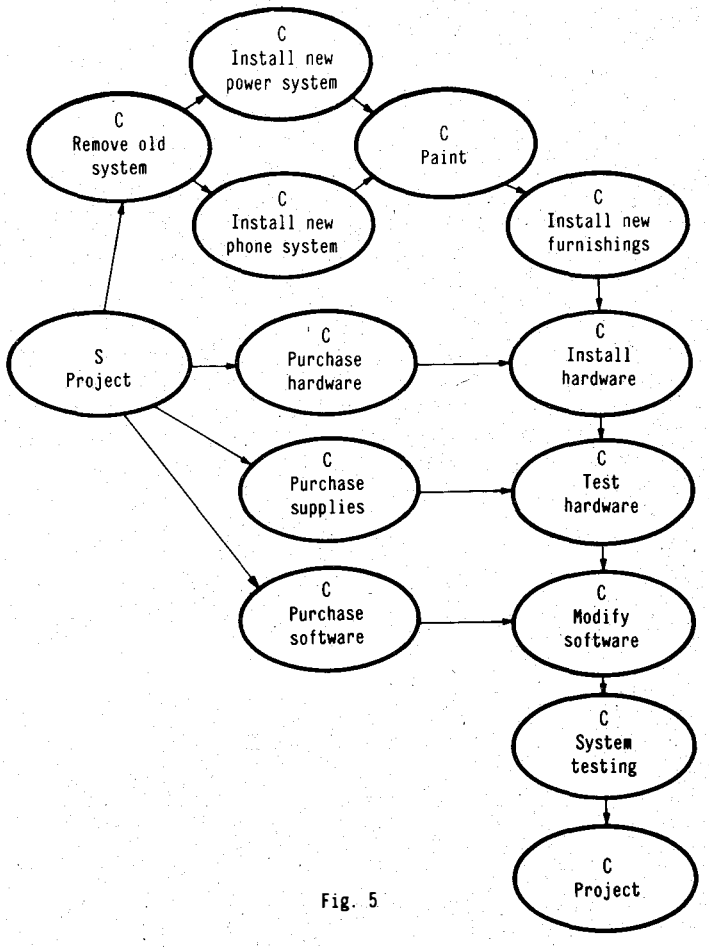

Fig. 5

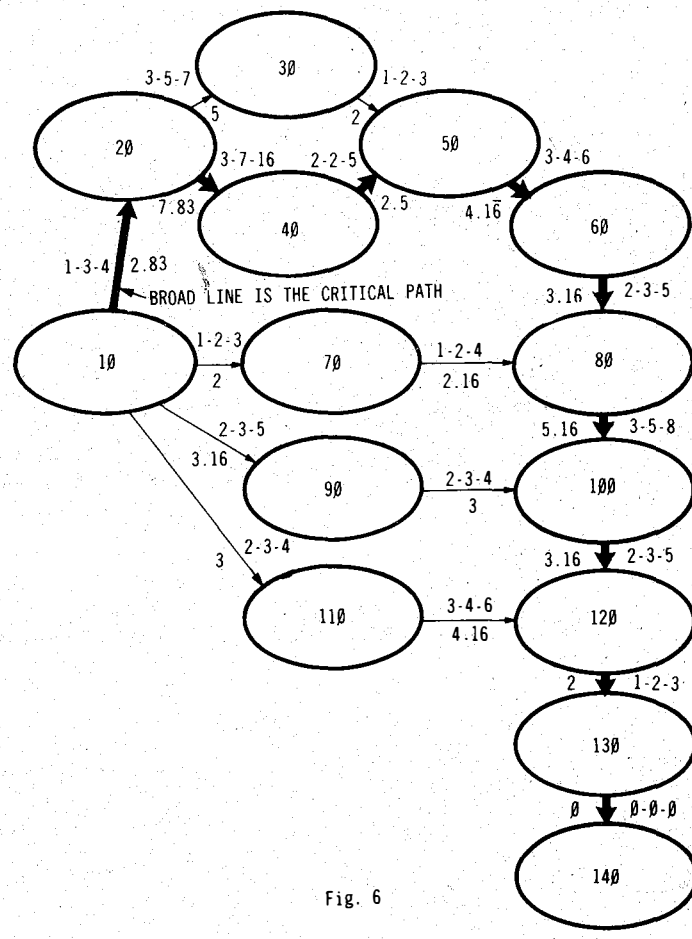

Fig. 6

testing) corresponds with the completion of the project, but the inclusion of event 130 with the dummy activity 130-140 maintains the logic of the network. The alternative method would be to eliminate event 130 and assign the 1-2-3 time time estimates to activity 120-140.

The critical path is simply the longest path though the network. The critical path in this example can easily be determined by inspection, using the t(a) times. We first look at the longer of the 20-30-50 and 20-40-50 paths. Using the longer, we next determine the longer of the 10-20-50-60-80 and 10-70-80 paths, and proceed in like fashion until the critical path is idenfified, by using the t(a) times in each case.

Three additional figures must next be calculated; the earliest expected time, T(E), the latest allowable time T(L), and the Slack time. The earliest expected time is the time when an event can be expected to be completed, and amounts to the sum of the expected times (t(a)) which precede it, with the longest t(a) being used where there is a choace, since an event cannot be achieved until all of the preceding activites are completed. The latest allowable time is that time by which an event must be achieved if the project is to be completed on schedule. The slack time for any path is the difference between the time scheduled for the project and that which is needed for the path. Slack can be positive or negative, and is positive if the time at which the final event of the path occurs is a time earlier than the project completion date. The slack is negative if it is a path with a longer time than the completion date. (Note that the path with the most negative slack is the critical path.)

For the example, we will assume that the scheduled completion time for the project is 30 days. After performing the necessary calculations, Figure 6 can be transformed into the tableau shown in Figure 7.

(See Figure 7 on page 52.)

The calculation of the latest allowable time, T(L)0, is done in a manner opposite to that of the T(E) calculation, in that the t(a) for each activity is subtracted progressively starting from the scheduled completion date, or the T(E) of the ending activity, if there is no T(S). This process continues back to the activity for which the T(L) is desired. Where there are two or more paths, the lower figure is used.

For an example of a T(E) calculation, suppose we wanted the T(E) of event 60. We sum the t(a)'s for the activites preceding event 60, using the longest t(a) time where there is a choice. Activity 10 - 20 t(a) = 2.83. Activity 20 - 50 necessitates using the path through event 40, so we would add the t(a) of activity 20 - 40 (7.83) and

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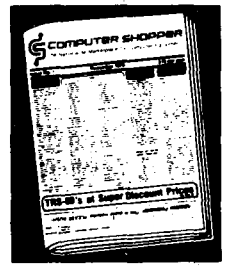

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Suc-cessor event	Prede-cessor event	to	tm	tp	ta	TE	TL	Slack
14Ø	13Ø	Ø	Ø	Ø	Ø.ØØ	3Ø.83	3Ø.ØØ	-Ø.83
13Ø	12Ø	1	2	3	2.ØØ	3Ø.83	3Ø.ØØ	-Ø.83
12Ø	11Ø	3	4	6	4.16	7.16	28.ØØ	2Ø.83
12Ø	1ØØ	2	3	5	3.16	28.83	28.ØØ	-Ø.83
11Ø	1Ø	2	3	4	3.ØØ	3.ØØ	23.83	2Ø.83
1ØØ	9Ø	2	3	4	3.ØØ	6.16	24.83	18.66
1ØØ	8Ø	3	5	8	5.16	25.66	24.83	-Ø.83
9Ø	1Ø	2	3	5	3.16	3.16	21.83	16.66
8Ø	7Ø	1	2	4	2.16	4.16	19.66	15.5Ø
8Ø	6Ø	2	3	5	3.16	2Ø.5Ø	19.66	-Ø.83
7Ø	1Ø	1	2	3	2.ØØ	2.ØØ	17.5Ø	15.5Ø
6Ø	5Ø	3	4	6	4.16	17.33	16.5Ø	-Ø.83
5Ø	4Ø	2	2	5	2.5Ø	13.16	12.33	-Ø.83
5Ø	3Ø	1	2	3	2.ØØ	9.83	12.33	2.5Ø
4Ø	2Ø	3	7	16	7.83	1Ø.66	9.83	-Ø.83
3Ø	2Ø	3	5	7	5.ØØ	7.83	1Ø.33	2.5Ø
2Ø	1Ø	1	3	4	2.83	2.83	2.ØØ	-Ø.83

Critical path

Fig. 7

Successor event	Predecessor event	to	tm	tp
25Ø	24Ø	2	3	4
25Ø	23Ø	2	5	1Ø
25Ø	22Ø	1	2	4
25Ø	21Ø	3	3	5
24Ø	2ØØ	3	7	16
24Ø	19Ø	4	6	1Ø
24Ø	12Ø	12	15	21
23Ø	18Ø	12	15	24
22Ø	17Ø	5	1Ø	16
21Ø	2ØØ	Ø	Ø	Ø
21Ø	16Ø	2	2	5
2ØØ	15Ø	12	16	26
19Ø	14Ø	1	1	2
18Ø	13Ø	3	4	6
17Ø	13Ø	2	4	5
16Ø	13Ø	1Ø	14	2Ø
15Ø	13Ø	3	5	8
15Ø	12Ø	1	1	2
14Ø	12Ø	2	3	5
13Ø	11Ø	9	14	22
12Ø	11Ø	5	8	14

Fig. 11

the t(a) of activity 40 - 50 (2.5). The t(a) of activity 50 - 60 is 4.16, and these four figures would sum to 17.33, which is the figure recorded in the T(E) column and the event 60 row of Figure 7)17g Suppose further, that the T(L) of event 60 is desired. The sum of the t(a) times from event 140 back to event 60 is subtracted from T(S) (30). This equals: 30 - (2.0 + 3.16 + 5.16 + 3.16) = 30 - 1.35 = 16.5 which appears in the T(L) column and the event 60 row of Figure 7.

Statistical Computations

The information calculated and delineated to this point can now be used to determine the probability of meeting the scheduled date. To recap briefly what has been calculated; the expected time t(a) divided the probability distribution into equal parts with one half of the area under the beta curve on each side and therefore a probability of success of 0.5. If we sum the t(a)'s along the longest path in the network (the critical path), we get the earliest expected time T(E) of the project, which has a 0.5 probability of being met. It is extremely doubtful that a certain project would have a scheduled completion date that coincided with the earliest expected time of the end event. Therefore, the probability of meeting the scheduled date would not be the 0.5 probability, but some other figure. The PERT user can find out this probability.

To determine this probability, we will make use of the fact that the probability distribution of T(E) for a project which has many activities is approximated in PERT by the normal distribution. We will therefore be concerned with normalization of our parameters so that we can use the normal distribution. To continue with the example, we are assuming the scheduled time, T(S), is 30 days, and we already know that T(E) is 30.83 days. This information can now be transferred to a simple normal distribution graph, such as Fig. 8, to provide an indication of the problem in visual form.

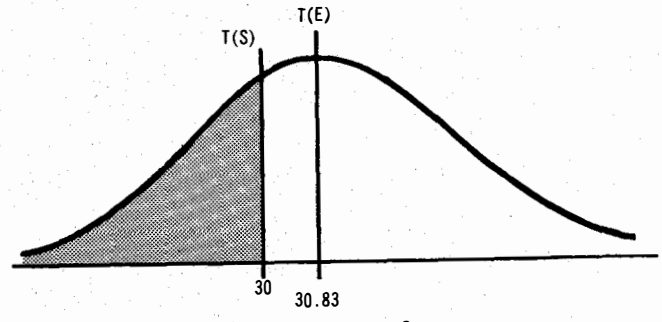

Fig. 1Ø

The problem now becomes one of calculating the shaded area on Fig. 8. We have several formulae which make use of the standard deviation (σ) of T(E) and the variance ($\sigma 2$). The basic formula can be stated as follows:

$$\sigma = \frac{T(S) - T(E)}{\sigma(\Sigma\sigma^2)}$$

where:

T(S) = scheduled completion time

T(E) = earliest expected time

$\Sigma\sigma^2$ = sum of the variance of the activities on the critical path (or other paths being considered).

$\sigma(\Sigma\sigma^2)$ = standard deviation of the sum of the variances

But σ, above, cannot be calculated as yet, because we do not know $\Sigma\sigma 2$.

To find the variance, $\sigma 2$, we use another PERT formula:

$$\sigma^2 = \left[\frac{t(p) - t(o)}{6}\right]^2$$

for each activity on the path, and then sum to get:

$$\Sigma\sigma^2 = \Sigma\left[\frac{t(p) - t(o)}{6}\right]^2$$

The calculations for the example are:

ıccessor event	Predecessor event	to	tp	tp- to	(tp- to)^2
14Ø	13Ø	Ø	Ø	Ø	Ø
13Ø	12Ø	1	3	2	4
12Ø	1ØØ	2	5	3	9
1ØØ	8Ø	3	8	5 &	25
8Ø	6Ø	2	5	3	9
6Ø	5Ø	3	6	3	9
5Ø	4Ø	2	5	3	9
4Ø	2Ø	3	16	13	169
2Ø	1Ø	1	4	3	9
				Sum:	243

Fig. 9

$$\Sigma\sigma^2 = \Sigma\left[\frac{t(p) - t(o)}{6}\right]^2 = \frac{243}{6^2} = 6.75$$

$$\sigma = \frac{T(S) - T(E)}{\sigma(\Sigma\sigma^2)} = \frac{30.0 - 30.83}{\sigma 6.75} = \frac{-0.83}{\sigma 6.75}$$

To find the σ of the $\Sigma\sigma 2$, (6.75), we simply take its square root, so that the calculations continue as:

$$\frac{-0.83}{\sqrt{6.75}} \cong \frac{-0.83}{2.598} \cong -0.32075$$

This last figure is now used as the entry to a table of the normal distribution, and the area under the shaded portion of Fig. 8 is found to be approximately 0.374486, which is interpreted in PERT to mean that there is a probability of 0.374486 that the project will be completed by the scheduled date or earlier.

Interpretation of Probability Figure, and "Crashing"

Depending upon the PERT user's interpretation of the probability figure, it can serve as the basis for several courses of action. If it is very low, the probability of meeting the schedule date is so low that the critical path time must be shortened. If it is very high, the likelihood of meeting the schedule date will be so high that a firm may want to consider utilizing some of the projects resources elsewhere in the firm on different projects. There is no fixed range of acceptabilihK-
robability. Perhaps the acceptable range might lie between probability figures of 0.25 and 0.30 at the low end, and 0.60 and 0.65 at the high end. Beyond these figures, it could be suggested that a shortening of the critical path time be investigated for the low probability case, or a moving of resources to other uses for the high probability case.

The course of action chosen should not depend only upon the probability of meeting the schedule date. This is because it is possible to have a low probability figure in a case when the time estimates are quite certain and the cumulative variance is small. The magnitude of the difference between the scheduled completion date and the date of expected completion will therefore be of interest ot the PERT user.

If the decision is made to shorten the critical path, there are several ways in which this may be done. It might be possible to eliminate some non-essential or not-very-essential activities. Of course, the additional risk of,say, elimination of time consuming tests or any other activities, would have to be weighed against athe time reduction achieved. Resources can be transferred from slack paths to critical paths. In some cases, where resources can not be easily transferred, it may be necessary to add resources. Added resources often mean the addition of manpower, and this can be accomplished in several ways: for example, overtime, extra employees, or subcontracting. It may be possible to either temporarily or permanently substitute a part of parts for other parts having long delivery times or special characteristics which can be waived. It may also prove possible to parallel activities that originally occurred in series. An example of this method of time reduction would be the paralleling of painting, installation of the new power system, and installation of the new phone equipment, in the example. The risk here would be that of getting paint on the electrical equipment, on the phone installer, etc.

In very large PERT programs, it is common practice to examine the first two to six or so critical and sub-critical paths. This is because a shortenign of the critical path might result in sub-critical paths becoming equal to it, and therefore, critical, or a new critical path may be formed.

PERT users should also realize that a critical path may always be bypassed by chance, since it is only most *likely* to be critical. Therefore, resource tradeoffs or crash measures will not have a probability of 1.0 of achieving the desired results.

Critical path time reduction can sometimes be accomplished by improving the variance along the critical path. This would be done by utilizing whatever control and expediting facilities exist. The target date would not be changed but there would be a reduction in the risk of deviating substantially from the target date.

The BASIC Program

The program, though long, is fairly straight-forward, and does all of the calculations previously discussed, plus it will sort input activities, so that they need not be entered in any particular order. This is especially desirable when input is being entered from a drawing of a network.

The program is currently formulated for up to fifty activities. This can be changed by modifying line 110. There will be enough room to add a few activities if you're using a 16k machine, and of course if you have additional memory, these dimensions can be raised considerably.

The mainline of the program, through line 999, simply calls various subroutines. This is basically an aid to testing and debugging.

Subroutine 1000 prints the basic PERT tableau. Screen display of the various times is limited to integers for the three time estimates, and is rounded to one decimal place for the calculated values in the last four columns. Since the tableau is likely to be larger than one screen can hold, the user is given the chance to scroll through it two or more times, before returning to the mainline program.

Subroutine 2000 is for inputting the data matrix. The successor event number, the predecessor event number, and the optimistic, most-likely, and pessimistic time estimates are entered in that order. A trailer row of all zero values is entered to terminate the input loop. In case an error is made that isn't caught until the line number, and then you are given a chance to "repair" the line before the program returns from the subroutine. The scheduled completion time is also input in this subroutine.

Subroutine 3000 allows the screen display to remain until the user presses the space bar. This routine is used several places in the program, and is called from some of the other subroutines.

Subroutine 4000 sorts the input matrix into a descending order PERT tableau, with the sort key being the successor event number.

Subroutine 5000 calculates the t(a), T(E), T(L), and Slack columns. The t(a) column is easily calculated, since it holds weighted averages of the values in the t(o), t(m), and t(p) columns. The T(E) column is calculated by working "up" the tableau from the bottom, beginning in line 5210 of the program. The T(E) is the sum of the expected times (t a) which preced it, with the longest t(a) being used where there is a choice. The T(L) column is calculated, starting in line 5420, by working "down" the tableau. Here, we start with the scheduled completion time, T(S), and the t(a) foq each activity is subtracted progressively starting from the T(S) and working down. Where there are two or more paths, the lower figure is used. The slack column is easily calculated by subtracting T(E) from T(L) for each activity.

Subroutine 6000 finds and prints the critical path. The critical path is found by first finding the lowest value in the slack column, and then identifying all of those activities that have this value. In lines 6060 to 6135, the slack times are rounded to one digit to the right of the decimal. This is so that slight computational differences and roundoff errors won't produce slack values that are very close but not exactly equal. If this were to happen, the activities associated with slack values only very slightly high, would not be identified as being on the critical path.

Subroutine 7000 calculates the various statistics leading up to the calculation of the probability of meeting the scheduled completion date. This subroutine then calls subroutine 8000 which does an integration of the area under the standard normal distribution. This subroutine uses the Trapezoidal Rule with interval widths of 0.01. This insures accuracy to the 5th or 6th digit to the right of the decimal.

Subroutine 9000 is simply some opening literals for the screen at the start of the run.

Figure 10 depicts the network for a nice little problem which will illustrate the use of the program. It is from a book by Harry F. Evarts, called *Introduction to PERT* (Boston: Allyn and Bacon, Inc., 1964), which I suggest for additional reading on the subject. We'll not worry about what wording goes with the event numbers, and the three time estimates will be presented in a worksheet for the tableau, shown as Figure 11.

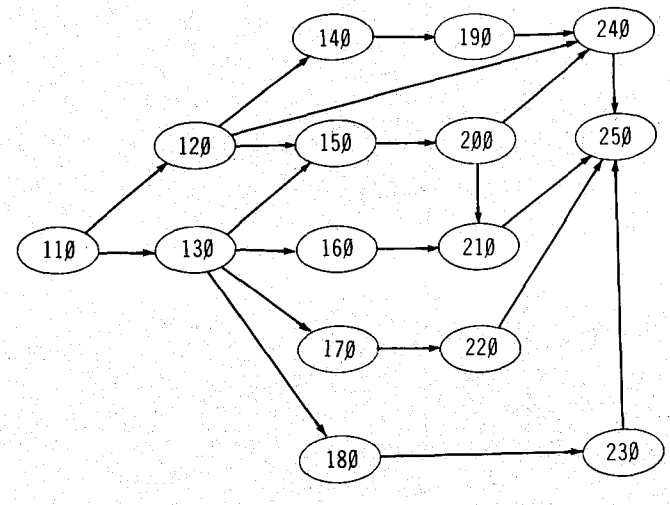

Figure 10

(See Figure 11 on page 52.)

After some opening remarks, the computer will ask that you input the starting matrix. Just to show that it works, enter the above table upside-down, and it will be stored. It should be entered as follows:

```
1?  12Ø,11Ø,5,8,14
2?  13Ø,11Ø,9,14,22
3?  14Ø,12Ø,2,3,5


19?  25Ø,22Ø,1,2,4
2Ø?  25Ø,23Ø,2,5,1Ø
21?  25Ø,24Ø,2,3,4
22?  Ø,Ø,Ø,Ø,Ø
```

When asked for the scheduled completion time, enter 45. The screen shown in Fig. 12 will now be printed

```
**************************************************************
SUC-    PREDE-
CESSOR  CESSOR
EVENT   EVENT     T(O)   T(M)   T(P)   T(A)   T(E)   T(L)   SLACK
**************************************************************
25Ø     24Ø         2      3      4     3.Ø   47.5   45.Ø    -2.5
25Ø     23Ø         2      5     1Ø     5.3   4Ø.Ø   45.Ø     5.Ø
25Ø     22Ø         1      2      4     2.2   3Ø.7   45.Ø    14.3
25Ø     21Ø         3      3      5     3.3   4Ø.Ø   45.Ø     5.Ø
24Ø     2ØØ         3      7     16     7.8   44.5   42.Ø    -2.5

14Ø     12Ø         2      3      5     3.2   11.7   34.5    22.8
13Ø     11Ø         9     14     22    14.5   14.5   12.Ø    -2.5
12Ø     11Ø         5      8     14     8.5    8.5   16.Ø     7.5
```

Fig. 12

The computer then finds the critical path, and Fig. 13 is printed:

SUCCESSOR EVENT	PREDECESSOR EVENT
25Ø	24Ø
24Ø	2ØØ
2ØØ	15Ø
15Ø	13Ø
13Ø	11Ø

Fig. 13

The last screen then shows that the sum of the variances along the critical path is 15.6389; the scheduled completion time, T(S), is 0.632175 standard deviations below the earliest expected time, T(E); and the probability of completing the project by the scheduled completion time or before, is 26.4351".

Summary

PERT can be applied to many management tasks to achieve lower cost and reduce project time and manpower needs. It has value in non-routine and non-repetitive operations, and differs from many other scheduling techniques in that it shows the interrelatinships of activities and events that comprise a project. PERT is often integrated with other methods of planning and control since PERT does not include cost, quantity, and quality constraints in its basic cnfiguration. PERT requires no sophisticated mathematics beyond a nodding acquaintance with statistics; and the computer allows a further reduction in handling the mathematical aspects of the problem.

```
1Ø REM
11 REM ************************************************
12 REM  *                                              *
13 REM  *   PERT (PROGRAM EVALUATION AND REVIEW TECHNIQUE)  *
14 REM  *                                              *
15 REM  *     BY:   C. BRIAN HONESS                    *
16 REM  *           COL. OF BUS. ADM.                  *
17 REM  *           UNIV. OF SO. CAROLINA              *
18 REM  *           COLUMBIA, SC 292Ø8                 *
19 REM  *                                              *
2Ø REM ************************************************
21 REM
1ØØ CLEAR 1ØØ
11Ø DIM M(5Ø,5), T(5Ø,9)
12Ø GOSUB 9ØØØ
13Ø GOSUB 2ØØØ
14Ø GOSUB 4ØØØ
15Ø GOSUB 5ØØØ
16Ø GOSUB 1ØØØ
17Ø GOSUB 6ØØØ
18Ø GOSUB 7ØØØ
19Ø PRINT : PRINT "   THAT'S IT!  HIT 'BREAK' AND"
2ØØ PRINT "    ENTER 'RUN' TO GO AGAIN."
21Ø GOTO 21Ø
999 END
1ØØØ REM ***  PRINT TABLEAU  ***
1Ø1Ø CLS : PRINT STRING$(64,"*");
1Ø2Ø PRINT " SUC-   PREDE-"
1Ø3Ø PRINT "CESSOR  CESSOR"
1Ø4Ø PRINT "EVENT   EVENT    T(O)   T(M)   T(P)   T(A)   T(E)
  T(L)   SLACK";
1Ø5Ø PRINT STRING$(64,"*");
1Ø6Ø A$ = " ###     ###      ##     ##     ##    ##.#   ##.#
  ##.#   ###.#"
1Ø7Ø FOR R = 1 TO N
1Ø8Ø PRINT USING A$; T(R,1),T(R,2),T(R,3),T(R,4),T(R,5),T(R,6),
T(R,7),T(R,8),T(R,9);
1Ø9Ø NEXT R
11ØØ PRINT : INPUT "  WANT TO SEE IT AGAIN ( YES / NO ) "; Y$
111Ø IF Y$ = "YES" THEN 1Ø1Ø
199Ø RETURN
2ØØØ REM ***  INPUT EVENT NUMBERS AND TIME ESTIMATES  ***
2Ø1Ø CLS : PRINT
2Ø2Ø PRINT "         ENTER EVENT NUMBERS AND THE THREE TIME"
2Ø3Ø PRINT "           ESTIMATES IN THE FOLLOWING ORDER :"
2Ø4Ø PRINT
2Ø5Ø PRINT "SUCCESSOR  PREDECESSOR  OPTIMISTIC  MOST-LIKELY
 PESSIMISTIC"
2Ø6Ø PRINT "  EVENT       EVENT        TIME        TIME
       TIME"
2Ø8Ø PRINT "   19Ø         14Ø          12          15
        24"
2Ø9Ø PRINT : PRINT "              LIKE THIS:
 19Ø,14Ø,12,15,24"
21ØØ PRINT
211Ø PRINT "ENTER A ROW OF ZEROS AFTER YOUR LAST ROW, LIKE
THIS: Ø,Ø,Ø,Ø,Ø"
212Ø PRINT
213Ø PRINT "        ( NOTE:  YOU NEED NOT ENTER THE ROWS IN
ANY"
214Ø PRINT "       ORDER, AS THEY WILL BE SORTED BEFORE
EXECUTION )"
215Ø GOSUB 3ØØØ
216Ø CLS : PRINT
217Ø PRINT "AGAIN, INPUT ORDER IS:"
218Ø PRINT
219Ø PRINT "   SUC-      PREDE-"
```

```
2200 PRINT "  CESSOR  ,  CESSOR  ,  T(0)  ,  T(M)  ,  T(P)"
2210 PRINT "  EVENT      EVENT "
2220 PRINT
2230 PRINT "   190,140,12,15,24          ( EXAMPLE )"
2240 PRINT
2250 PRINT TAB(15) "IF YOU DISCOVER ANY INPUT ERRORS,"
2260 PRINT TAB(15) "MAKE A NOTE OF THE LINE NUMBER(S)"
2270 PRINT TAB(15) "AND CONTINUE ON.  YOU'LL BE GIVEN"
2280 PRINT TAB(15) "A CHANCE TO RE-ENTER THEM LATER. "
2290 PRINT : PRINT "   HERE WE GO ....."
2295 GOSUB 3000
2300 CLS : PRINT
2310 PRINT " 190,140,12,15,24       ( EXAMPLE )" : PRINT
2320 I = 1
2330 PRINT I; : INPUT M(I,1),M(I,2),M(I,3),M(I,4),M(I,5)
2340 IF M(I,1) = 0 THEN 2370
2350 I = I + 1
2360 GOTO 2330
2370 N = I - 1
2380 PRINT
2390 PRINT "  ARE THERE ANY LINES YOU WANT"
2400 INPUT "    TO RE-ENTER ( YES OR NO ) "; Y$
2410 IF Y$ <> "YES" THEN 2460
2420 PRINT : INPUT "  WHICH LINE DO YOU WANT TO CHANGE"; L
2430 PRINT "  LINE "; L ; " IS CURRENTLY: ";M(L,1); ",";
M(L,2);",";M(L,3);",";M(L,4);",";M(L,5) : PRINT "  RE-ENTER
IT NOW:"
2440 INPUT M(L,1),M(L,2),M(L,3),M(L,4),M(L,5)
2450 GOTO 2380
2460 PRINT
2470 INPUT "  WHAT IS SCHEDULED COMPLETION TIME, T(S) "; TS
2480 PRINT : PRINT "  TABLEAU IS NOW BEING CALCULATED"
2990 RETURN
3000 REM ***   WHEN READY PRESS 'SPACE' ROUTINE  ***
3010 PRINT @ 960, ".....PRESS.....WHEN
READY.....";
3020 FOR k= 1 TO 30:K$=INKEY$: IF K$<>"" THEN RETURN ELSE NEXT K
3030 PRINT @ 985,"'SPACE'";
3040 FOR K=1 TO 30:K$=INKEY$: IF K$<>"" THEN RETURN ELSE NEXT K
3050 GOTO 3010
4000 REM ***   SORT INPUT MATRIX INTO PERT TABLEAU  ***
4010 FOR R = 1 TO N
4020 REM * FIND LARGEST SUCCESSOR EVENT NUMBER *
4030 B1 = 0
4040 FOR I = 1 TO N
4050 IF M(I,1) <= B1 THEN 4070
4060 B1 = M(I,1)
4070 NEXT I
4080 REM * FIND LARGEST PREDECESSOR EVENT FOR THAT SUCCESSOR *
4090 B2 = 0
4100 FOR I = 1 TO N
4110 IF M(I,1) <> B1 THEN 4140
4120 IF M(I,2) <= B2 THEN 4140
4130 B2 = M(I,2)
4140 NEXT I
4150 REM * FIND ROW WITH SUCCESSOR = B1, PREDECESSOR = B2 *
4151 REM * LOAD IT INTO THE R'TH ROW OF THE TABLEAU, AND  *
4152 REM * THEN 'ZERO OUT' THIS ROW IN THE INPUT MATRIX.  *
4160 FOR I = 1 TO N
4170 IF M(I,1) <> B1 THEN 4250
4180 IF M(I,2) <> B2 THEN 4250
4190 T(R,1) = M(I,1)
4200 T(R,2) = M(I,2)
4210 T(R,3) = M(I,3)
4220 T(R,4) = M(I,4)
4230 T(R,5) = M(I,5)
4240 M(I,1) = 0 : M(I,2) = 0
4250 NEXT I
4260 NEXT R
4990 RETURN
5000 REM ***  CALCULATE LAST 4 COLUMNS IN TABLEAU   ***
5010 REM * CALCULATE T(A) FOR EACH ACTIVITY *
5020 FOR R = 1 TO N
5030 T(R,6) = ( T(R,3) + 4 * T(R,4) + T(R,5) ) / 6
5040 NEXT R
5050 REM * CALCULATE T(E) FOR EACH ACTIVITY.  FIRST, FIND *
5060 REM * NUMBER OF SAME SUCCESSOR NUMBERS. STORE THIS  *
5070 REM * TEMPORARILY IN T(R,9). *
5080 R = 1 : R1 = 1
5090 C = T(R,1)
5100 K = 1
5110 IF T(R+1,1) <> C THEN 5150
5120 K = K + 1
5130 R = R + 1
5140 GOTO 5110
5150 FOR R2 = R1 TO R
5160 T(R2,9) = K
5170 NEXT R2
5180 IF R = N THEN 5210
5190 R = R + 1 : R1 = R
5200 GOTO 5090
5210 REM * NOW FIND T(E) FOR EACH ACTIVITY *
5220 T(N,7) = T(N,6)
5230 FOR R = N-1 TO 1 STEP -1
5240 IF T(R,2) <> T(N,2) THEN 5270
5250 T(R,7) = T(R,6)
5260 NEXT R
5270 R3 = R
5280 FOR R = R3 TO 1 STEP -1
5290 FOR R4 = R+1 TO N
5300 IF T(R4,1) = T(R,2) THEN 5320
5310 NEXT R4
5320 IF T(R4,9) <> 1 THEN 5350
5330 T(R,7) = T(R4,7) + T(R,6)
5340 GOTO 5410
5350 B3 = T(R4,7)
5360 K = T(R4,9)
5370 FOR R5 = R4 TO R4+K-1
5380 IF T(R5,7) > B3 THEN B3 = T(R5,7)
5390 NEXT R5
5400 T(R,7) = B3 + T(R,6)
5410 NEXT R
5420 REM * CALCULATE T(L) FOR EACH ACTIVITY *
5430 FOR R = 1 TO N
5440 T(R,8) = 999999
5450 NEXT R
5460 T(1,8) = TS
5470 FOR R = 2 TO N
5480 IF T(R,1) <> T(1,1) THEN 5500
5490 T(R,8) = TS
5500 R6 = R
5510 FOR R = R6 TO N
```

```
5520 B4 = T(R,1)
5530 FOR R7 = R-1 TO 1 STEP -1
5540 IF T(R7,2) <> T(R,1) THEN 5570
5550 B5 = T(R7,8) - T(R7,6)
5560 IF B5 < T(R,8) THEN T(R,8) = B5
5570 NEXT R7
5580 IF T(R,1) <> T(R-1,1) THEN 5600
5590 T(R,8) = T(R-1,8)
5600 NEXT R
5610 REM * COMPUTE SLACK VALUE FOR EACH ROW *
5620 FOR R = 1 TO N
5630 T(R,9) = T(R,8) - T(R,7)
5640 NEXT R
5990 RETURN
6000 REM ***   FIND AND PRINT CRITICAL PATH   ***
6010 CLS : PRINT : PRINT "   CRITICAL PATH :" : PRINT
6020 PRINT TAB(14) "SUCCESSOR      PREDECESSOR"
6030 PRINT TAB(14) "  EVENT           EVENT"
6040 PRINT
6050 B8 = 999999
6060 FOR R = 1 TO N
6070 IF T(R,9) < 0 THEN 6100
6080 T(R,9) = T(R,9) + 0.05
6090 GOTO 6110
6100 T(R,9) = T(R,9) - 0.05
6110 T(R,9) = T(R,9) * 10
6120 TF= FIX( T(R,9) )
6130 T(R,9) = TF / 10
6135 NEXT R
6140 FOR R = 1 TO N
6150 IF T(R,9) >= B8 THEN 6170
6160 B8 = T(R,9)
6170 NEXT R
6180 FOR R = 1 TO N
6190 IF T(R,9) <> B8 THEN 6210
6200 PRINT, T(R,1), T(R,2)
6210 NEXT R
6220 GOSUB 3000
6990 RETURN
7000 REM ***   CALCULATE STATISTICS FOR CRITICAL PATH   ***
7010 CLS : PRINT : PRINT "   CRITICAL PATH STATISTICS : "
7020 PRINT : S1 = 0
7030 FOR R = 1 TO N
7040 IF T(R,9) <> B8 THEN 7060
7050 S1 = S1 + ( (T(R,5) - T(R,3)) ↑ 2 )
7060 NEXT R
7070 S2 = S1 / 36
7080 PRINT "   SUM OF VARIANCES = "; S2
7090 S3 = ( TS - T(1,7) ) / SQR(S2)
7100 PRINT : PRINT "   nO. STD. DEV. FROM "
7110 PRINT "     MEAN TO T(S)   = "; S3
7120 GOSUB 8000
7130 PRINT : PRINT "   PROBABILITY OF COMPLETING"
7140 PRINT "     PROJECT BY T(S) = "; AR ; "%"
7150 PRINT
7990 RETURN
8000 REM ***   CALCULATE AREA UNDER NORMAL DISTRIBUTION   ***
8010 PI = 3.14159
8020 E = 2.71828
8030 S4 = 0 : L = 0
8040 TM = 1 / SQR ( 2 * PI )
8050 U = ABS ( S3 )
8060 A = 0.01 : B = U - 0.01
8070 FOR X = A TO B STEP 0.01
8080 Y = TM * E ↑ ( -X ↑ 2 / 2 )
8090 S4 = S4 + Y
8100 NEXT X
8110 AL = TM * E ↑ ( - L ↑ 2 / 2 )
8120 AU = TM * E ↑ ( - U ↑ 2 / 2 )
8130 AR = 0.01 / 2 * ( AL + 2 * S4 + AU )
8140 IF T(1,7) < TS THEN 8170
8150 AR = ( 0.5 - AR ) * 100
8160 GOTO 8990
8170 AR = ( 0.5 + AR ) * 100
8990 RETURN
9000 REM ***   OPENING SCREEN   ***
9010 CLS : PRINT : PRINT TAB(21) "***  P E R T  ***"
9020 PRINT
9030 PRINT TAB(10) "PROGRAM EVALUATION AND REVIEW TECHNIQUE"
9040 PRINT
9050 PRINT TAB(15) "BY:    C. BRIAN HONESS"
9060 PRINT TAB(22) "COL. OF BUS. ADM."
9070 PRINT TAB(22) "UNIV. OF SO. CAROLINA"
9080 PRINT TAB(22) "COLUMBIA, SC  29208"
9090 GOSUB 3000
9100 RETURN
9990 RETURN
```

Program Constraints

1. 50 activities, *including* trailer row of zeros to shut off input loop. Change DIM in line 110 (both M and T) to raise.

2. Event numbers <=999. Usual convention is multiples of 10. No successor event event may have a smaller number than any predecessor event behind it.

3. Time estimates should be integers <=99.

4. In the unlikely event that there are two or more critical paths through the network, the results of the statistical calculations will be incorrect.

This situation can be detected however, when the events on the critical path are delineated. In other words, it will print:

SUCCESSOR EVENT	PREDECESSOR EVENT
110	90
110	80
90	70
80	70

instead of:

110	90
90	70

or:

110	80
80	70

for this network segment:

continued on page 62

THE GRAFTRAX CONNECTION

George F. Greenwald

Perhaps others of you were attracted by Epson's marvelous ads to buy "Graftrax", their super-duper graphics add-on the their very fine printer, the MX-80. Well, super it is . . . once you get past some of the misinformation in their manual, and find out how the graphics really function.

Being a novice at the TRS-80 Model III, I was, nevertheless, challenged by the possibilities of outputting high-resolution graphic plots of equations . . . a somewhat limited version of the engineering-quality plots I'm used to seeing on higher-powered machines.

Since I am a great believer in flowcharting, I set to work, and developed what appeared to be a well structured program, punched it up . . . and with some explanation from Epson on how to get into graphics mode from a Model III, ran headlong into repeated "beeps" from the printer, accompanied by nothing but random and meaningless output. The beeps are Epson's way of announcing an illegal command (and masking the four letter words streaming from the computer room). While the manual for Graftrax does not have the proper commands for communications from the Model III computer, their staff was very accomodating in supplying the needed information. Unfortunately, it was not quite right. In repeated calls to Epson, I was assured that the commands they were recommending have worked successfully for others and should be working for me . . . the error had to be in my program logic. Swell!

Where had I gone wrong? I am embarrassed to reveal how many hours I have spent debugging my program, even though I *knew* it was correct. After weeks of chasing, I finally gained the courage to decide that just maybe it *wasn't* my logic. Finally, I set the large program aside and wrote a simple program to output a single line of graphics according to Epson's suggested method. Surprise! I got the same beeps, and the same meaningless output. So, I was right after all!

Here is the simple program, which, according to Epson, should output a row of 400 dots and a line feed:

```
10 B=400
20 LPRINT CHR$(27);"K";CHR$(144);CHR$(1);
30 FOR I=1 TO B: OUT 251,4 :NEXT I
40 LPRINT ""
50 END
```

In line 20, "CHR$(27)" is an "escape", "K" sets the graphics mode, and the next two characters determine the number of points the printer is to expect; the first is just a number, while the second is a "toggle" that adds 256 to the first number if the value is 1, and adds zero if the value is zero. Thus for my program, 144 + 256 = 400. Since the Model III cannot pass certain numbers to the printer using the "CHR$" command (another uncharted land to be discovered), Epson recommended the use of the "OUT" command; apparently both "OUT 251" and "OUT 248" work equally well (or poorly, depending on your point of view). Line 40 just forces a line feed at the end of the print.

Many more hours of "playing" revealed that if the toggle were set to zero, I would get 144 dots, as advertised. Or stranger still, if the toggle were left set to 1, but "B" in line 10 were set equal to a value greater than 500, I got precisely 400 dots (counted with a magnifier many times).

More conversations with Epson, and more experimentation! Finally I asked the right question, and got my first real lead. I had noticed that the printhead would never print all 400 dots in one pass, but "homed" after 240 dots, and then returned to continue printing right where it had left off. Epson informed me that that sequence was intentional, since the printer buffer can only store 240 characters. When the buffer is full, the head prints; after 240 dots, it stops printing, but inertia moves the head past the last dot, and the head is then out of register for the next set of dots. The head is homed to pick up a new reference. They suggested that I add a line of code to determine whether any characters were being added or deleted during this recycle. My additional line was:

```
35 FOR I=1 TO 100: OUT 251, 65 :NEXT I
```

Since 65 is ASCII for the letter "A", and since it is also the code used to turn on the 1st and 6th dots, I should get some clue as to whether any characters were lost. If I were losing characters during the homing process, I would get additional dots (1 and 6) printed; if not, one hundred letter A's would be printed. Success at last! I got only one letter "A" output.

The message was quite clear: while the head is homing, the computer continues to output information, but the printer buffer is not recording that information. Hence, lost characters. What I needed was a time delay to give the head time to return. I changed the program to read:

```
10 B=240:C=350
20 LPRINT CHR$(27);"K";CHR$(144);CHR$(1);
30 FOR I=1 TO B: OUT 251, 4 :NEXT I
40 FOR I=1 TO C: NEXT I
50 FOR I=1 TO 160: OUT 251, 4 :NEXT I
60 LPRINT ""
70 END
```

It worked like a charm! Line 40 is a simple time delay; I found that a loop of 350 was long enough for my machine. You may need to modify that number in the event your machine is faster or slower; it really isn't critical as long as the time is long enough for the head to recycle. A program sequence such as the above is essential if one is to use the high resolution graphics capability.

So, now back to square one to finish designing the graphics output I wanted to have in the first place!

George F. Greenwald
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Huntington Beach, California 92646 ■

SERIOUS TBUG

High Memory TBUG with Hardcopy Option

Steve Brown

If you're like me you've found that: 1. Far too often TBUG is too low in memory.

2. A hard copy of all those bytes would sure be easier to read than 16 at a time.

This article will show you how to modify your TBUG program to get rid of these two headaches. What's more, it will take only about 30 minutes.

Moving TBUG into High Memory

First, load TBUG. Then go to memory location 4980H and enter the bytes indicated in Listing #1. Next enter J 4980. Bingo! You now have TBUG in high memory locations 7380H-797FH. Just enter P 7380 797F 7380 HIBUG. The next time you need TBUG in high memory, just load HIBUG.

Dumping Core

If you'd like the option of printing core in the same form in which I printed Listing #2, then read on.

First, load HUBUG. The go to memory location 7980H and enter the bytes indicated in Listing #2. You must also put 5AH in address 73FDH, 80H in address 73FFH, and 79H in address 7400H. Save to tape by entering P 7380 7A60 7380 MODBUG.

Dump memory by pressing Z. This will cause "ENTER STARTING ADDRESS" to appear in the lower left corner of the screen. Enter a hexadecimal address, and it will print out from there. Press the BREAK key to stop printing.

```
4980-21-80-43-11-80-73-01-00-
4988-06-7E-FE-43-FA-97-49-FE-
4990-4A-F2-97-49-C6-30-77-ED-
4998-A0-EA-89-73-32-EF-74-32-
49A0-73-32-89-73-32-EF-74-32-
49A8-0A-75-32-E1-76-32-1A-77-
49B0-32-2C-77-3E-44-32-E9-74-
49B8-3E-45-32-FE-74-32-92-76-
49C0-32-34-77-3E-46-32-E6-73-
49C8-32-F8-74-32-3A-77-3E-47-
49D0-32-FD-73-32-8C-75-32-AD-
49D8-75-32-75-76-32-A6-76-32-
49E0-B4-76-32-DB-76-32-43-77-
49E8-32-76-77-C3-80-79-00-00-
49F0-00-00-00-00-00-00-00-00-
```

Listing #1

```
7980-CD-C9-01-21-4F-7A-11-C0-
7988-3F-01-17-00-ED-B0-FD-21-
7990-66-7A-06-04-C5-CD-84-03-
7998-FE-40-CA-95-79-FE-30-FA-
79A0-95-79-FE-47-F2-95-79-47-
79A8-E6-0F-FE-0A-F2-95-79-CD-
79B0-33-7A-78-12-13-C1-10-DC-
79B8-3A-66-7A-CD-45-7A-3A-67-
79C0-7A-80-67-3A-68-7A-CD-45-
79C8-7A-3A-69-7A-80-6F-3A-40-
79D0-38-CB-57-C2-80-73-CD-DE-
79D8-79-CD-EA-79-18-F0-7C-CD-
79E0-1E-7A-7D-CD-1E-7A-CD-01-
79E8-7A-C9-06-08-7E-CD-1E-7A-
79F0-CD-01-7A-23-10-F6-3E-0D-
79F8-32-E8-37-06-80-CD-60-00-
7A00-C9-3E-2D-32-E8-37-CD-C9-
7A08-01-C9-FE-0A-F2-13-7A-F6-
7A10-30-18-04-D6-09-F6-40-32-
7A18-E8-37-CD-C9-01-C9-57-E6-
7A20-F0-CB-3F-CB-3F-CB-3F-CB-
7A28-3F-CD-0A-7A-7A-E6-0F-CD-
7A30-0A-7A-C9-78-FE-40-F2-3D-
7A38-7A-E6-0F-18-02-C6-C9-FD-
7A40-77-00-FD-23-C9-CB-27-CB-
7A48-27-CB-27-CB-27-47-C9-45-
7A50-4E-54-45-52-20-53-54-41-
7A58-52-54-49-4E-47-20-41-44-
7A60-44-52-45-53-53-20-07-09-
7A68-08-00-00-00-00-00-00-00-
7A70-00-00-00-00-00-00-00-00-
```

Listing #2

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BEGINNER'S CORNER

continued from page 47

machine language. I often fantasize that I should take all of these sources and combine the best descriptions and diagrams that could explain it all in one text. Unfortunately, that would mean that there would be one more wonderful text on BASIC, and I'm sure that's just what the world is waiting for. (Wouldn't it be great?!)

At any rate, I'm sure you get my point. Rather than waste your time on a text that may have some terrific information for you but isn't the best organized or most cleverly written, I think it pays to have a back up text that allows you at least to get your money's worth. If there are those with differing opinions, then this publication recognizes its right to allow you to write to someone you like and tell them all about it.

If you can't think of anyone you like, then you can write to me. I love getting mail. See you next time at the old B.C.

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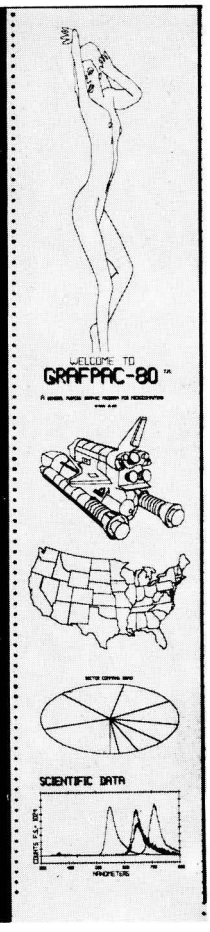

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COLOR COMPUTER CORNER

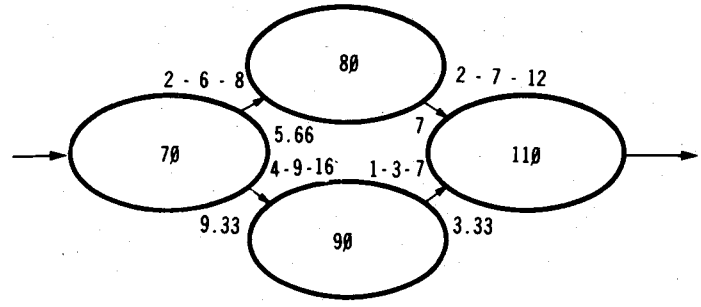
continued from page 43

```
Label   Command Argument      Comment
START   LDA     #$Ø           Get a zero into the A reg.
LOOP    LDX     #$4ØØ         Load address 4ØØH into X.
SCREEN  STA     ,X+           Store A into contents of X,
                              INC X.
        CMPX    #$6ØØ         End of video?
        BNE     SCREEN        If not, fill next location.
        JSR     WAIT          Pause for awhile.
        JSR     WAIT
        JSR     WAIT
        INCA                  Get next ASCII character.
        BNE     LOOP          If not done, repeat disp.
DONE    SWI                   Done, return to OS.
WAIT    LDB     #Ø            Get a zero.
LOOP2   TFR     D,Y           Save accumulators.
        MUL                   AB=A*B
        TFR     Y,D           Get accumulators back.
        INCB                  Add one to B.
        BNE     LOOP2         If not zero, repeat.
        RTS                   Zero, done - return.
        END
```

PROGRAM LISTING

PERT

continued from page 57



The sum of that t(a) times along each path is 12.66 since

Path	Σt(a)
7Ø-8Ø-11Ø	5.66 + 7 = 12.66
7Ø-9Ø-11Ø	9.33 + 3.33 = 12.66

It would therefore seem that both paths are critical, but in reality the 70-90-110 path is the critical path since it has the higher variance.

Path	to	tp	tp- to	$(tp- to)^2$
11Ø-8Ø	2	12	1Ø	1ØØ
8Ø-7Ø	2	8	6	36
				136

var = 136/36 = 3.77

11Ø-9Ø	1	7	6	36
9Ø-7Ø	4	16	12	144
				18Ø

var = 18Ø/36 = 5

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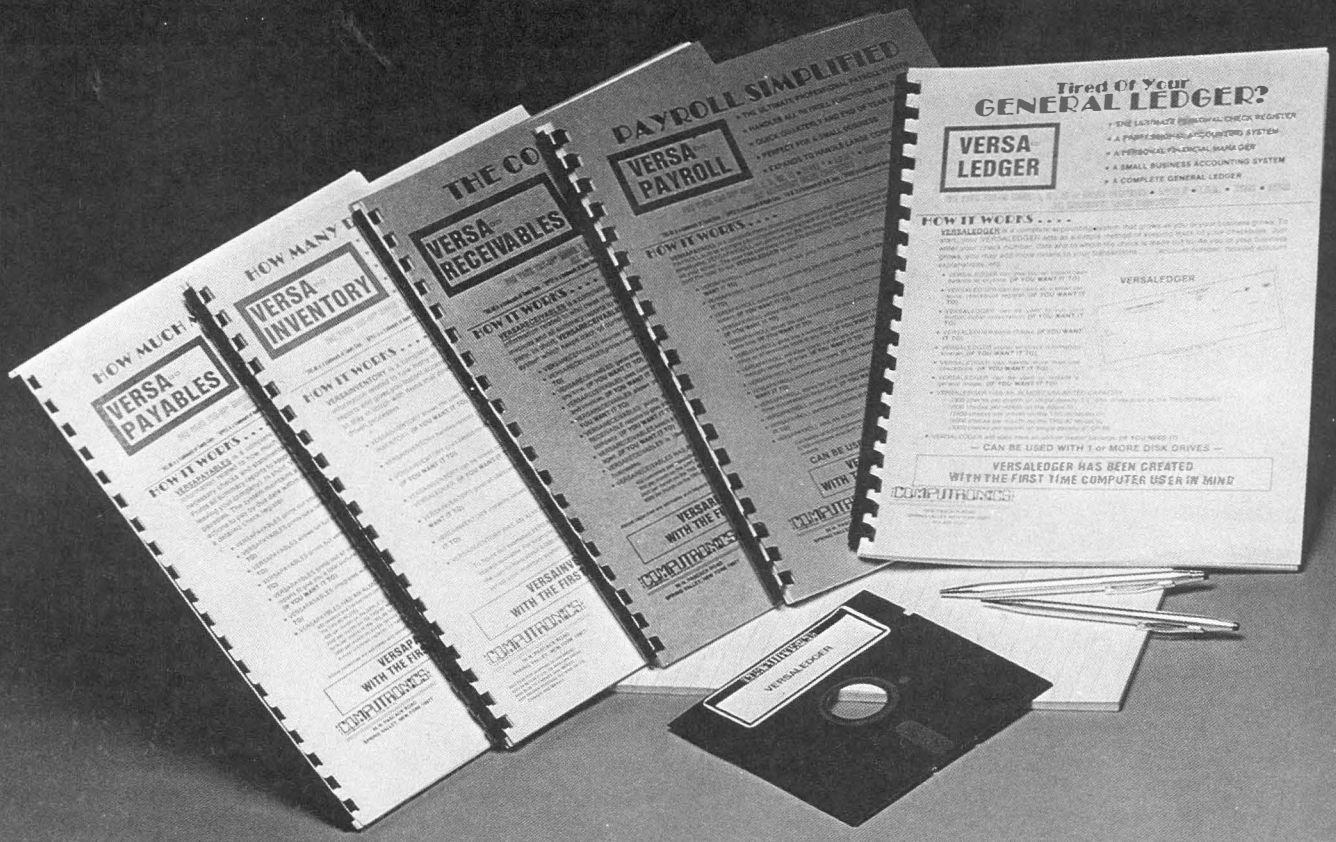

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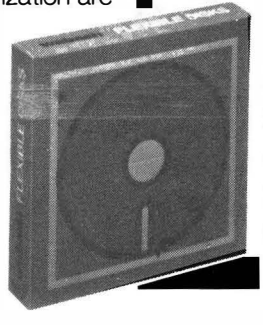

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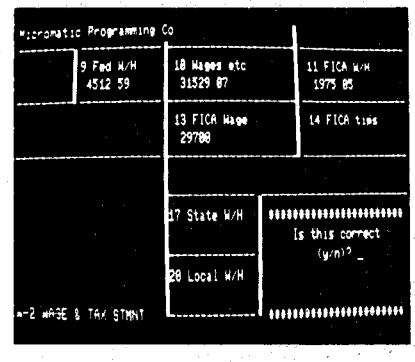

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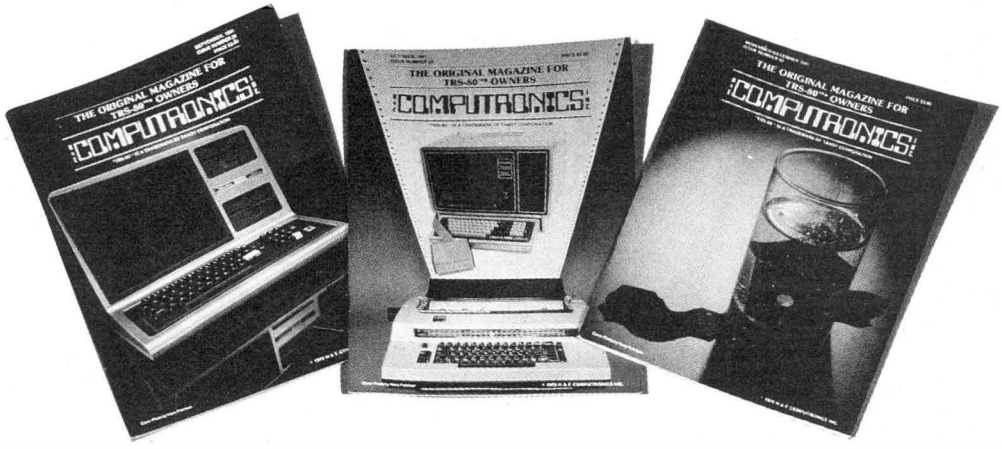

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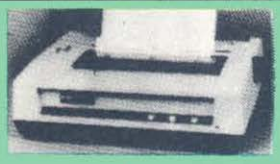

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