Structured Programming With The Microsoft M80 Assembler

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Concurrent DOS, 6808, 8086, 90286, IBM PC, PCXT, AT ............................................. Digital Research Inc.

MS-DOS, XENIX ............................................. Intel Corporation

GW Basic, 80000, 80100, 80200 ............................................. International Business Machines

Microsoft ............................................. Microsoft

Motorola ............................................. Motorola

@Micro/Systems Journal is always seeking good articles. Please write or call first to see if we are interested in the subject. Please do not send the article unless we ask for it. If you are interested in reviewing hardware or software please write telling us your interests, your background and include a sample of your writings. Send a stamped self-addressed business size envelope for a copy of our Author's Guide.
A Report

To The Subscriber

We have been in operation now for six months and have put out three issues. It is therefore an opportune time for us to take stock of how well we are doing. In some ways we are doing well and in others not so well.

WHERE ARE WE DOING WELL?

It is apparent from the reader response that, with few exceptions, our readers are delighted to have the magazine back again. And they like the content. We have also found that authors are eager to have their articles appear here. There are more articles submitted to us than we have the space to publish and thus we are able to pick the best.

The feedback from our advertisers is also very positive. Virtually every advertiser has signed up for repeat advertising. The rates are low, quality is high and several of our advertisers have told us that advertising in Micro/Systems Journal pays the best returns for them of any publication they advertise in.

We have no advertising sales staff. Yet our advertising has increased with each issue. We have 68 advertisers in this issue, up from 62 and 57 in our previous issues. This increase in advertising has enabled us to increase the size of the magazine from 80 to 88 pages.

We are maintaining an advertising/editorial ratio of 40/60 while most other computer magazines are just the reverse... 60% advertising and only 40% editorial. Further, we attempt to pack in as much editorial as possible by omitting space consuming artwork and white space that convey no information whatsoever. Thus, we feel that we provide as much technical content as magazines twice our physical size... and more important, we feel we provide a much higher quality of technical content.

WHERE ARE WE NOT DOING WELL?

We now have six months of operation under our belts. And, the hectic time of signing up over 8,000 subscribers in three months is over. We have thus had the opportunity to assess how we are doing financially. The situation is not encouraging.

We are operating a real low-budget operation. We have no rental space (we operate out of our home). We have no full time employees; only a little bit of part-time help. We have not drawn any salary. We are resigned to a labor-of-love philosophy.

But there are expenses that must be incurred... printing, typesetting, postage, telephone, etc. It is very expensive getting this operation up off the ground.

It is apparent to us that we are a long way from breaking even. The basic problem appears to be in reaching the "economy of scale", the "critical mass", necessary to make this a possible endeavor. Our circulation is still only 17% of the old Microsystems and advertising less than 40%. Most of our expenses are overhead expenses. Hence, we must grow in circulation and advertising income to cover these expenses.

ASSESSING THE SITUATION

We are committed to investing a year's worth of our labors to this magazine. We are cutting expenses wherever we can, without sacrificing quality.

Therefore, we are appealing to you, our readers, to help us make this magazine live again. Please tell your friends to subscribe. If you belong to a User Group please promote it to the group's members (call or write us as to how you can help).

Please tell your local computer dealers, college and technical bookstores to carry the magazine on their racks. Please do not ask to be billed for subscriptions — we have found that less than half of the bill-me's actually pay and the mailing of issues and billing expense makes this a losing proposition.

You can help in other ways as well. If you move, please notify us promptly. You would not believe what it costs us for returned torn off covers from the Post Office. The P.O. will not forward second class mail. We then have the additional expense of mailing a second issue to the subscriber. So please, if you are going to move notify us well before hand and tell your P.O. that you want to have your magazines forwarded.

Also, when renewal comes around, please renew promptly so that we don't have to send you additional notices. Or better yet, renew early. You will notice the date of your last issue in the upper right corner of your mail label. Incidentally, one of our advertisers, Competitive Edge, is offering a free subscription to Micro/Systems Journal, or an extension of an existing subscription, when you purchase selected products from them. Check their ad for details.

You can also help us in another and very important way. Please tell advertisers that you saw their ads in Micro/Systems Journal and urge others to advertise.

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—Lennie & Sol Libes
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GOSSIP & RUMORS
Kudos to Altos, the first company to introduce a Motorola 68020-based system, a true 32-bitter. Their Altos 3068 runs Unix System V serving up to 30 users.

Ashton-Tate has stopped selling its multi-user version of DBase II in the U.S. and Canada although it is still shipping it in international markets. The reason... low sales. The software, introduced in May '84 was designed to work with the 3/Com LAN. A-T also disclosed it has dropped development work on a Turbo-DOS version.

Western Digital and Xebec, the two leading makers of hard disk controller systems are sampling new controllers for 3.5 drives that reduce the parts count to one quarter of current controller cards and require only one connecting cable to the drive instead of the current two. This is expected to significantly reduce the cost of hard disk systems.

ATARI, who had promised to show a prototype of their new 32-bit personal computer running Unix, at the Hanover Fair in April, failed to do so. In the meantime, Mark Williams Co. disclosed that Commodore will use their Unix-like Coherent operating system on their new C900 personal computer. The entire operating system has been squeezed into 2Mbytes of disk space and supports up to seven users. The C900 will have a 1024 by 800 pixel bit mapped display.

Clone makers are switching from the PC to the AT marketplace. Expect Tandy, Hewlett-Packard, Texas Instruments, Zenith, Wang, Honeywell, Philips, Siemens, Ericsson, and AT&T to shortly introduce AT-compatibles. There are even rumors that Apple is seriously considering producing one. Most are expected to make their display circuitry compatible with IBM's Enhanced Graphics Adapter (EGA). Chips and Technologies, a custom IC maker in San Jose CA is reported attempting to integrate the EGA from 150 down to 23 IC's.

Microsoft is expected, late this year, to release MS-DOS 4.0, adding multitasking and the ability to access a virtual memory in excess of 640K. The addition of multitasking is expected to improve the operating speed of Microsoft's WINOWS environment. Currently, the only way to get multitasking on PC-compatible machines is with one of the Unix implementations (e.g. Xenix, Coherent, etc.) or Digital Research's Concurrent-DOS whose latest version (4.1) also includes the GEM Mac-like user interface.

Version 5.0, designed specifically for the 80286 is expected early next year. It should execute programs in the 80286 protected virtual-address mode. DIK has already begun shipping its 826 version of Concurrent-DOS to OEMs. However, it has been reported that current 80286 production devices contain a bug which prevents Concurrent-DOS 826 from implementing the protected virtual-address mode while maintaining MS-DOS compatibility. Intel is aware of the problem and expects to correct it shortly.

Intel Unwraps 386
Intel will shortly formally announce its new, long rumored, 32-bit microprocessor, the 80386. Intel currently finds itself running behind National Semiconductor (already shipping 32032 in production quantities) and Motorola (in limited 68020 production) and AT&T (shipping their Bellmac-32 chip set to OEMs). Intel is not expected to start samples until this fall with production to start next year.

The 386 will have more than twice the devices housed in the 286 and be two to three times faster. It should have on-chip memory management with both protection and paging features to work with up to a 4-gigabyte physical memory and 64-terabytes virtual memory.

Intel has halted all development work on its previous 32-bit microchip set, the 432 (although High Integrity Systems, in England is continuing a 432 development effort). Intel is reported working on a new high-end 32-bit chip set, code name P-7, believed to be a less complex implementation of the 432, optimized for real-time work and easier to use than the 432.

The 432 was actually the first 32-bit microprocessor to be introduced (way back in '81). It contained a very innovative architecture but its performance proved disappointing. Intel introduced an improved version in '83 and added fault-tolerant features. But by that time Motorola and National had entered the market.

Look for at least one S-100 manufacturer to release an S-100 CPU card using one of the new 32-bit microprocessors before year-end. Expect more next year. We would be interested in hearing from readers as to how they feel the S-100/IEEE-696 bus standard should be upgraded to accommodate these 32-bit CPUs.

Z80K & Z800, WHERE ARTH THOU?
Zilog has again pushed back introducing its Z80,000, 32-bit and Z800 super 8/16-bit (Z80 compatible) microprocessors, to the spring of '86. If they do manage to ship samples, then it will be a full six years since Zilog announced they were developing the devices.

Zilog, owned by Exxon, has shown a profit in only one year of its 11 year life and recently cut close to 400 people from its payroll. Although a microprocessor pioneer with its Z80 and Z8000 8- and 16-bit microprocessors, it has suffered from a reliance on microprocessor manufacturing while competitors, such as Intel, Motorola and National, have used microprocessors as
loss leaders to sell memory and other types of ICs.

USER GROUP & PUBLIC DOMAIN NEWS

The Apple II CP/M Library, Box 477, Kulpsville PA 19443 is furnishing copies of the entire SIG/M Public Domain Software library on 5.25 Apple disks. Send a stamped self-addressed business size envelope to receive an abbreviated catalog. Send $3 for a detailed printed catalog or $10 for catalog on disk.

CLERGY KUG is a user group serving Ministers, Priests and Rabbis using KayPro equipment. They have a 1200 program library for the KayPro which they share and also publish a small newsletter. For info contact Elmer F. Little Jr., 3868 Centorbi Court, Florissant MO 63034.

Users wishing SIG/M public domain software on Morrow MD-3 disks (single or double sided) can obtain them ($6 volume) from G.L. Harris, Box 797, Metuchen NJ 08840.

The Amateur Computer Group of New Jersey, the club that sponsors the SIG/M and PC/Blue public domain software libraries has started a public domain software library for the Apple Macintosh computer. The library already contains several volumes. For information send $2 and a stamped self-addressed business size envelope to: MAC-UG, c/o Keith Sproul, 698 Magnolia Rd, No. Brunswick NJ 08902.

RANDOM BITS

Novix, Cupertino CA has introduced a 16-bit microprocessor that directly executes the FORTH language...... Tarbell Electronics, Carson CA, is shipping an S-100 CPU card with 80186 and Z-80 processors that can directly boot CP/DOS......Computer Language magazine will conduct a C-Language seminar/workshop, September 16-18 in Cambridge MA. For more info, call (415)957-9353 or write CL Publications, 131 Townsend St, San Francisco, CA 94107......Digital Research has established a special User Group Forum on CompuServe (type Go PCS-13) and has a number of DRI engineers online as well as extensive data libraries and technical info......Intel is offering a system (called the Intel Personal Super Computer, or IPSC) consisting of up to 128 IBM AT boards, each containing 512K of ram and an 80287 math coprocessor. Total memory is 16Mbytes and the CPUs operate in parallel. They promise performance equal to that of a Cray-1 and are recommending the system for artificial applications at a fraction of the cost and size of a Cray-1.

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5. The Libraries Linkable ZCPR3 libraries (Vlib, 23lib, and Syslib3) of over 400 subroutines used for Assembly Language program writing. Simplifies structured, efficient code production; online help system and full source code provided ........................................ $45.00
6. Syslibrary alone ........................................ $29.00
7. Term3 New generation communication program permits menu control of computer/modem operations between operator and time-share services, bulletin-boards and other remote computer systems; auto-answer to command-line prompt ........................................ $99.00
8. Discat Fancy file and disk catalog program running under Z-System, menu driven and easily customized by operator ........................................ $49.00

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Micro/Systems Journal July/August 1985
Dear Lennie:

Since you are dealing with MICROSYSTEMS previous subscribers, I thought you might be interested in passing along the following information.

I had a 3 year sub to MICROSYSTEMS when Z-D folded it, and sent me a PC TECH JOURNAL instead. I have a North Star system; what would I want with PC TECH JOURNAL?

I called and wrote with no success. Finally, I got angry enough and located a way of stopping PC TECH JOURNAL and getting a full refund from the last issue of MICROSYSTEMS.

First, Call 1-800-525-0643 and request they instantly stop PC TECH JOURNAL.

Second, Call Ro Carbone at (212) 503-5396 and request a full refund. It worked for me.

Good luck to your readers.

T. L. F.

Dear Mr. Libes:

We wish you success in this venture. Along with many other long suffering users we are fed up with the machinations of so called professional management that ends up in the demise of good ventures because it didn't make them instant millionaires. It is a significant factor in the economic malaise in this country as professional management seems to think that they are the owners instead of the stockholders.

Charles C Wright
San Ysidro CA

Dear Sol:

Glad to hear you are back again and all the very best to you and the new venture. PLEASE lets have a publication that does more than blab incessantly about MSDOS and the IBM backward step standard and looks after us die hards with our old or Ancient S100 systems.

John T Linnell
Etobicoke Canada

The S-100 marketplace is actually doing quite well as it keeps at the forefront of the changing technology with high speed 16-bit systems and powerful hardware that enable users to build multi-user and multi-processing systems. One can pick from a wide variety of 8- and 16-bit processors, and in the near future 32-bit processors as well. Also, keep in mind that one can run many up-to-date operating systems on S-100 equipment; systems such as CP/M, Turbo-DOS, Concurrent-DOS, MS-DOS and Unix. Thus, I expect S-100 to be with us for quite some time to come.

CP/M-80, however, I think is another matter. By today's standards it is an "old" operating system and lacking the power and features needed to take the best advantage of today's powerful hardware systems. ZCPR3, as well as some other utilities have brought some of the newer features to CP/M-80. However, the fact that so few software developers are bringing out new software for CP/M-80 indicates that users should start looking at other operating systems that allow them to run the current generation of applications programs on their S-100 systems. We are attempting to publish articles to help our readers in this effort.

the editor

Dear Lennie & Sol:

It was a pleasure to receive the premiere issue of Micro/Systems Journal. I was pleased to see both the superb editorial content and a healthy compliment of advertising.

I hope the return to garage publishing is as pleasant for you both as the return of Microsystems was to me. You will shortly receive both a company and a personal subscription check from me. Microsystems was the only 'micro' book I was subscribing to when I joined ZD and Micro/Systems Journal is the only one I pay for myself. I wish you both the best of luck.

Jonathan D. Lazarus, Vice President
Ziff-Davis Publishing Company

Dear Sol:

I'm hesitantly backing your play. As a hardware kit-builder and software hacker, I feel that I really got the shaft on your previous venture. I'm looking for a good S-100, hardware-oriented magazine. Somewhere along the line, the idea was foisted upon the world that S-100 and CP/M were synonymous. They AIN'T! I have recently purchased a Digital Research Corp. Big Board.

Your front-page headline proclaiming "Bringing Up CP/M-Plus" really turns me off. What I want to see are articles about putting other CPU's on the S-100 bus, or else redefining the damned thing to get a 32-bit data path to accommodate either the NS32032 or MC68020 (along with 2-4 Mbytes of unsegmented and unmapped linear memory. Intel and Zilog can go soak their collective heads!

Peter A Thiessen
Mercer Island WA

Dear Sol:

I do not want to read any publication that discusses, addresses, considers, reviews or otherwise mentions IBM, IBM-PC, XT, AT, etc. While I do not believe in censorship, I do not wish to contribute in any way to the acknowledgement of IBM except to damn them in every way.

Bernard S Gorman
Eatontown NJ

Readers will find the name of IBM in several places in this issue, in previous issues and no doubt in future issues. There is no doubt that IBM has a very dominant position in the microcomputer marketplace. This fact cannot be ignored. To do so is to act like an ostrich with the resulting consequences. The PC, XT and AT hardware configurations and bus systems have become de facto standards as dozens of other manufacturers have adopted this architecture.

We also feel that IBM is getting more than enough exposure in other publications and therefore we do not plan to promote IBM products here. However, we feel that many of the IBM-compatible products are being ignored in the computer press and deserve to be brought to the attention of our readers and therefore we will be carrying articles on these products.

We feel that the PC-bus, MS-DOS and Concurrent-DOS are today, generic to the industry and we expect to treat them as such. We do not intend to review any IBM products or products that run exclusively on IBM systems. However, products that are compatible with de facto standard PC hardware and MS-DOS will be discussed here. To do so would be hiding our heads in the sand and trying to ignore many very worthwhile products that are out there.

Dear Sol:

I would like to report an error in David Brewer's article in issue #1. Please refer to subroutine ZIP, in listing 1 on page 48 (FINDEM program). The subroutine works fine for digits 0 thru 9 but is in error for digits A-F hex. The...
binary number 1010 (decimal 10) is transformed to 40H, rather than 41H (ASCII for "A"), so the final value must be incremented to produce digits A-F. I have altered the subroutine as follows:

ZIP:
AND 0FH
ADD A, 90H
DAA
ADC A, 40H
DAA
; FOLLOWING THREE INSTRUCTIONS ADDED
CP 40H
JR C, ZI
INC A
; LABEL ADDED TO NEXT INSTRUCTION
ZI
CALL SENDA
RET

Charles Prohaska
Dingman's Ferry PA

Dear Mr. Libes:

I received my first copy of your new journal in the mail today, and I was happy to note that your journal has maintained high standards of both quality and usefulness. I own an S-100 system, and for a number of reasons, I'm glad I got aboard the S-100 bus, IBM popularity et al!

One statement you made in the "Editor's Page" really got my attention in one big hurry! You said that "... four largest suppliers of S-100 systems are using Unix." I guess you meant Cromemco (?), Altos, and ?? Who were you referring to? I have an MS-DOS system (Seattle CPU, Tarbell controller, etc.) and I'm very interested in migrating to Unix. I'd like to keep my Microsoft compiler and other MS-DOS tools and run them in a Unix environment!

The closest I've come so far is Dynacomp Computer Systems, Vancouver B.C., (604)872-7737 and Mississauga, ONT. (416)826-8002, which runs on a CompuPro 8/16E.

Anthony B Price
Burbank CA 91501

We expect to publish a review of the Dynacomp Unix implementation of the CompuPro 8/16 in the near future. The S-100 vendors who currently are shipping Unix systems include Cromemco, Morrow Designs and Dual Systems. Also, I expect that CompuPro and Macrotech will begin shipping S-100 Unix implementations before year-end.

Micro/Systems Journal July/August 1985
In the SIG/M Public Domain

by Stephen M. Leon

Is it true that only people on the wrong side of sanity spend weeks writing and debugging software only to donate it to the public domain? What normal person tolerates telephone calls in the middle of the night from strangers with questions that range from exceedingly clever to patently absurd? At least some of the local "breathers" and cranks take a couple of hours off at night for rest - but when its 3 AM your time and 6 PM at the caller's location, he gets annoyed if you don't respond promptly! Besides that, the person on the other end of the phone is not a crank caller. He or she is someone YOU promised to help when you put your name and phone number in the documentation.

If there is a word to describe such a person, that word might be teacher. Over the past ten years personal computing has been transformed from a tool of the hackers to a near appliance for the non-technical user. Moreover, while many of the former supporters of public domain have gone commercial, there is still a significant group of people who continue to support the public and its needs, without compensation, often at personal sacrifice.

Nowhere are these teachers more evident than in the group that continues to support CP/M. Much of the PC/MS-DOS public domain software support comes not from people who are earnestly trying to help, but from the vultures of "freeware" whose motto is If you like it - send me money.

Personal computing is worldwide - and SIG/M functions on an international basis as a rallying point for the dedicated supporters of CP/M. In addition, there is a worldwide forum where much of this group meets. The CP/M SIG on CompuServe is the classroom of CP/M personal computing. Each of us probably gets six invitations a week to spend hundreds of dollars at a seminar to learn the truth about something in computing, but reading the messages on the CompuServe CP/M SIG will teach you more than any seminar. Where else can one get together with a faculty of Bill Bolton, Ward Christensen, Irv Hoff, Pete Holsberg, Sigi Kluger, Gary Novosielski, Harry Van Tassel, etc., etc., and get answers that are not hems and haws, but the right stuff. If the message board is a great way to get expert help fast, an even more interesting session is the on-line conference held Sunday evenings at 9:00 Eastern.

We persuaded one of the CompuServe regulars, Sigi Kluger, to donate a volume of his software to the SIG/M library. In the past, we have placed some of his works on miscellaneous volumes, but this time we were fortunate enough to obtain from him what is now Volume 226 - the Sigi Kluger Utilities.

Utilities are programs or modules you never notice until you discover them. A week after Sigi's disk arrived, it became necessary to cut the baud rate on my CompuPro system from 19,200 cps to 1,200. His SETBAUD went into the startup file and the problem was solved. Sure there were plenty of other ways to solve the problem, but with Sigi's utility handy, why not use it?

Get yourself a SIG/M catalog or order the catalog disk (Volume 00) and thumb through all of the utilities that are available. Do you use VFILER? You don't even know what it is? Then you use SWEET? What about FINDBAD or SD? At least you use DU and UNERA!

If these names mean nothing then your CP/M-based computer is running at quarter speed. Rather than tell you what they are - get your checkout and send a $10.00 check to SIG/M Box 97, Iselin, NJ 08830. Tell us whether you are running CP/M-80 or CP/M-86, and whether or not you can read an 8" single density disk. If you can't, notwithstanding the fact that SIG/M does not directly support anything but 8" SSSD, we will do our best to get you a 5" disk in the format you specify. SIG/M will send you a catalog and a sample disk as soon as possible. The extra dollar added to the charge is because this sample volume is not a regular release volume.

Jim Van Zandt has done an update to Ron Cain's Small C. His version with floating point math is on newly released Volume 224. A word of caution, it runs only on a Z80. A CP/M-86 version of Small C is available on SIG/M Volume 149 (but without the floating point).

On newly released Volume 225, Paul Gans, a regular contributor to the SIG/M library, has come up with a program for MX-80 owners. It allows you to run Wordstar and have a second character set. Included in Paul's package is a scientific font for the MX-80. Also on 225 is a series of biochemical games and simulations from Henry R. Bungay of RPI. Professor Bungay's works may not have universal appeal, but that too is one of the virtues of the SIG/M library. We don't try to appeal to everyone on every volume. We do try to have something for everyone at some time or another. However, no commercial distributor could ever release an eight volume set of the Yale Catalog of Bright Stars (Volumes 31 through 38). Funny thing, we are constantly getting requests for this series. This is a clear demonstration of the need for public domain distribution of even limited appeal software.

The Capital Osborne Users Group donated three dBASE applications to SIG/M from their library. One is a checkbook balancing program. Another is a genealogy program. The final program is a church management system. These applications are found on Volume 227.

SIG/M Volumes are available on 8" SS SD Disks for $6.00 (9$0.00 foreign) directly from SIG/M, Box 97, Iselin, NJ 08830. Printed catalogs are $3.00 each ($4.00 foreign). Disks in a variety of formats may be obtained through the worldwide SIG/M distribution network. The distributor list is included with the printed catalog. A disk version of the catalog (Volume 00) is available for $6.00.
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Micro/Systems Journal July/August 1985

Csharp Realtime Toolkit

Systems Guild, Inc., P.O. Box 1085, Cambridge, MA 02142
(617) 451-8479
The contribution of material to the PC/Blue public domain software library comes from many different sources. A major repository of public domain software happens to be on the vast multitude of Bulletin Board Systems. Since I am also the system operator for the New York Amateur Computer Club Bulletin Board System, many users upload files from other bulletin boards. That is in the best tradition of networking.

Many contributed programs are sent via mail to the Amateur Computer Group of New Jersey and to the New York Amateur Computer Club. All programs donated to the public domain are welcome and appreciated. A general screening of the submissions is made to ensure that user-supported programs are not limiting in their condition for distribution. We recently received a very nice little system from an author who specifically stated that if you do not send him a “donation”, you must destroy the material in your possession after 10 days or else you would be subject to liabilities.

The collected material is then reviewed for prior duplication, latest revision update, reasonable working operation and freedom from violation of copyright restrictions. Afterwards, the programs and related files are, loaded en masse, onto a fixed disk. Subcataog by topics are created or carried over for the purposes of classification of materials. Topics include communications, games, utilities, applications, and system functions.

Programs are then grouped together into preliminary volumes. To insure some compatibility between IBM clones, we have chosen to use the lowest common denominator which is an 8-sectored-per-track, double-sided format. If there are single-sided users, they probably have “buddies” who can make the simple conversion for them. The trial volumes are then cataloged into a table of contents known as the -CATALOG.mnn file. As a general rule, the diskette will contain from about 250 to 310KB. Occasionally a diskette may use the 9-sectored format. PC/Blue Volume 117 is a case in point. It is a wholly self-contained system that just barely went over the 320KB capacity.

In the latest releases, it should be noted that Lotus Development should be commended for placing certain materials into the public domain. This represents a major change in attitude by key software vendors. They had always been wary that the public may confuse all of their materials as being public domain and as such available for use and distribution. This has not happened. The ready availability of applications dependent on a proprietary package serves the interests of the public, as well as the authors.

A topic of major concern is the distribution of user-supported software in the public domain network. In the IBM world, user-supported software comprises the major volume of what is available in public domain programs. It has become increasingly difficult for the beginning cottage industry author to get his software to the marketplace. Most, if not all, of the major publishing sources will not deal with the untested new author who wishes to strike out on his own.

Many would-be start-up software entrepreneurs now begin with the user-supported concept. The tenant is simply to have the program available to be freely distributed. If you, the recipient, like it please don’t feel embarrassed to send in the suggested donation. This eliminates expensive overhead for advertising. As a general rule, people tend to build libraries, so the released program will have an ever-expanding audience.

The following are the newly-released PC/Blue public domain software volumes.

Copies of the PC/Blue printed software directory can be ordered from Micro/Systems Journal, Box 1192, Mountainside NJ 07092 ($4 U.S., Canada & Mexico; $6 foreign).

Editor's Note: Hank Kee is the librarian for the PC/Blue public domain software library. He is the person who collects, assembles, and checks all the software issued by PC/Blue and then compiles and edits them into the released volumes.

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by Melvin O. Duke

118 PC-Talk (.EXE) v2.1
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QModem v104
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119 NewKey v2.13
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120 Investment Record System
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122 Symphony Applications
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Super Multifunction Card! Zenith Z-100 • IEEE-696

- REAL-TIME CLOCK CALENDAR
- Alarm, Heartbeat, Standby Interrupts
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P-SST

The Programmable Speech/Sound/Time Card by LP Systems, Inc. is a multifunction peripheral card designed to IEEE-696 (S-100) bus standards. The best selling accessory card for the H/Z-100 series of computers from Heath Co. and Zenith Data Systems, it is also adaptable, with appropriate software, to most systems which meet the IEEE-696 standard.

The P-SST combines those functions and features most requested by H/Z-100 users and programmers. Complete schematics and documentation, as well as extensive software support, make the P-SST useful to the novice as well as the advanced programmer. The P-SST is an "open" system, and user development of applications software is encouraged.

SOFTWARE

Current distribution and development software supports the use of the H/Z-100 series of computers under MS-DOS/ZDOS, and CP/M-85/86 and any CP/M 2.2 IEEE-696 system.

Distribution software for the H/Z-100 includes automatic demonstration batch files, and demonstration programs for speech, music, graphics, sound, and joystick use.

Utility programs include a hardware diagnostic program for the P-SST, background music interrupt, and a clock read program to automatically set the time and date in MS-DOS/Z-DOS on boot-up.

Three-voice ASCII music scores are provided for use with the demonstration programs, and as examples of how to prepare scores for input to the MUSIC program. Notation used is similar to that for the IBM-PC BASICA "PLAY" command, for which many scores are available.

The SPEECH program will output words through the speech synthesizer from a specified ASCII text file.

Optional software includes the P-SST Development Libraries ($49.95), for use with most high level language compilers, and the MAESTRO Music Editor ($39.95) for music scoring and composition. The Development Libraries include over 50 subroutines, functions, and source code for most of the distribution demonstration and utility programs. MAESTRO allows graphic display and editing of music scores, back-ground music utility programs, and an additional 50 three-voice music scores.

P-SST is also supported by the following Software Wizardry programs:

- CHRONOLOGIC clock program
- PALETTE color graphics editor
- REACTOR-100 Nuclear reactor simulation (sound/voice)
- ZLYNK/II smart modem communications (clock/calendar)
- ESP Bulletin Board/Dial-in (clock/calendar)

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Turbo Pascal Corner

by David W. Carroll

This column features tips and techniques for using Turbo Pascal productively on MS/PC-DOS and CP/M microcomputer systems. It discusses typical problems and their solutions. Reader’s suggestions, comments, and questions are encouraged. Address them to:

Turbo Pascal Corner
Box 699
Pine Grove, CA 95665

In this issue, we will take a look at handling simple data translations in Turbo Pascal. We will develop a program to solve a sample problem that requires a byte-to-hex code translation. The task will be to design a file dump utility for MS-DOS (or CP/M with a few modifications) that will list a file's contents in both hex and ASCII on the screen.

The basic algorithm has to read the input file sequentially in byte format, translate each byte to its hex and ASCII equivalent (if printable) and display it on the screen. We will also display the data address in the file, and offset the starting address by 100 hex for .COM type files.

The pseudo-code for this is shown in listing 1.

```
LISTING 1
Get File Name
Open File
If fileext = .COM then address starts at 100h else 0
While not eof
  Translate address to hex
  Print address
  While not eol (on screen - 16 bytes)
    If not eof do
      Get byte
      Translate to 2 hex digits
      Print Hex digits and space
      For printable ASCII character substitute
      Add to ASCII print string
    Else
      Write blanks to fill line & string
    End;
  End;
  Print ASCII String
  Print CR-LF
  If end of block (address FOh), print blank line
  Increment address by 16
End;
Close file
End.
```

The only sub-procedure required in the preceding example is a routine to translate a byte of data into its two digit hex equivalent and then in ASCII for display. Pascal provides a number of methods to code this translation, including using an array or a CASE$formula$ combination.

In both cases, the first step is to isolate the low and high order nibbles (4 bits) of the data byte to be converted. This is easily done with the code:

```
hbyte := databyte div 16;
lbyte := databyte mod 16;
```

**ARRAY METHOD**

Using the array method, we first set up an array [0..15] of characters. Then each member of the array is initialized with the correct ASCII character as determined by the hex value established by the first part of the main program. The procedure `trans()` accepts a byte of data and prints the two character hex code on the screen:

```
procedure trans(indat:byte);
var
  hexbyte : string[3];
  hbyte   : byte;
  lbyte   : byte;
begin
  hbyte := indat div 16;
lbyte := indat mod 16;
  hexbyte[0] := chr(hbyte);
  hexbyte[1] := hex[lbyte];
  write(hexbyte);
end;
```

**CASE METHOD**

Although arrays can be useful for complex, irregular coding plans, they are not a very elegant solution to the translation problem, especially where the data follows some regular pattern or scheme. The CASE statement provides an alternative in this particular problem with the use of the ordinal ASCII values for the formula based translation (listing 2):

```
LISTING 2
procedure trans(indat:byte);
var
  bdat : byte;
  ch   : char;
procedure xlt;
begin
  case bdat of
  0..9   : ch := chr(bdat + ord('0'));
 10..15 : ch := chr(bdat + ord('A') + 10);
else
  ch := 'X'; {error on input value}
end;
xlt;
begin
  bdat := indat div 16;
  write(ch);
  bdat := indat mod 16;
  xlt;
  write(ch);
end;
```

Finally, we can simplify even further by using a function in the translate procedure.
CONVERSION OVERFLOWS

An interesting problem showed up during the development of the program when an integer type variable was used for the address counter. Guess what happens when a file is larger than 32K bytes? The answer is that the address will exceed the MaxInt value for Turbo and be displayed as a negative, or cause a run-time error. This problem can be avoided by using a real for the address and converting it, although the conversion can prove to be an interesting exercise in itself. And, what if you want to dump a file larger than 64K? This requires printing a 6 digit hex address instead of four digits.

The real to integer conversion process can be tricky, due to the automatic type conversions in Turbo. Intermediate results can exceed MaxInt, producing negative numbers unexpectedly or causing run-time errors, depending on the type of result variable. See if you can find the bug in this test program to convert a real number to a two integer byte value:

```pascal
program test1;
var
  rec : real;
  hrec : byte;
  lrec : byte;
begin
  rec := 65534.0;
  writeln('input value = ',rec:5:0);
  hrec := trunc(rec / 256);
  writeln('high order byte = ',hrec);
  lrec := trunc(rec - (hrec * 256));
  writeln('low order byte = ',lrec);
end.
```

This program generates a run-time error 92 at the statement:

```
   lrec := trunc(rec - (hrec * 256));
```

because the intermediate result of (hrec * 256) is of type Integer causing a negative overflow (in the example shown, hrec = 255 and the intermediate integer result of (255 * 256) is -256 rather than 65280 as expected). In the incorrect example above, Turbo computes:

```
lrec := trunc(65534.0 - (255 * 256))
```

and returns the run-time error because the trunc() value is greater than 32767.

To correct the problem, at least one of the operands must be of type Real to force the result to be of type Real and eliminate the overflow. Here is the corrected statement:

```
   lrec := trunc(rec - (hrec * 256.0));
```

The Turbo 2.0 reference manual states, *If both the operands of the multiplying and adding [categories of] operators are of type Integer, then the result is of type Integer. If one (or both) of the operands is of type Real, then the result is also real.* What is not obvious is that this rule also applies to the IN-TERMEDIATE results in the evaluation of a complex expression.

The simple program, shown in listing 3, demonstrates the difference between the results than can be obtained, i.e. the integer result is -256 and the real result is 65280 - quite a difference.

LISTING 3

```pascal
program test2;
var
  hrec : byte;
  xxx : integer;
  yyy : real;
begin
  hrec := 255;
  xxx := hrec * 256;
  writeln('integer intermediate value = ',xxx);
  yyy := hrec * 256.0;
  writeln('real intermediate value = ',yyy:5:0);
end.
```

FILEDUMP UTILITY

Now we can put these ideas together to create the final FILEDUMP utility program as shown in listing 4:

LISTING 4

```pascal
{FileDump.pas
Turbo Pascal Ver. 2.0
PC-DOS Version
Copyright 1985 by David W. Carroll
Date: 4/23/85
Version: 10
}

program filedump;
const
  bell 07;
  version '10';
type
datstr data file string[20): file of byte;
var
  infile data file asc;
  filename string[20];
  asclitext string[20];
  sec secl col msec hsec lsec goodfile quit boolean;
  dat byte;
  msec byte;
  hsec byte;
  lsec byte;
  goodfile boolean;
  quit boolean;
procedure trans(indat:byte);
var
  ch : char;
function xlt(bdat: byte) : char;
begin
  case bdat of
    0...9 : xlt := chr(bdat + ord('0'));
    10..15 : xlt := chr(bdat + ord('A') - 10);
    else
d  ch := 'X';
  end;
end;
begin
  ch := xlt(indat div 16);
  write(ch);
  ch := xlt(indat mod 16);
  write(ch);
end:
```

```pascal
procedure trans(indat:byte);
var
  ch : char;
function xlt(bdat: byte) : char;
begin
  case bdat of
    0...9 : xlt := chr(bdat + ord('0'));
    10..15 : xlt := chr(bdat + ord('A') - 10);
    else
d  ch := 'X';
  end;
end;
```

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begin
  ch := xlt(indat div 16);
  write(ch);
  ch := xlt(indat mod 16);
  write(ch);
end;

procedure Uppercase(var Str : datstr);
var
  indx,len : Integer;
begin
  Len := length(Str);
  for Indx := 1 to len do
    Str[Indx] := UpCase(Str[Indx]);
end;

begin
  asciitext[0] := chr(16); [set ASCII string length]
  sec := 256; [set initial .COM address]
  quit := false;
  ClrScr;
  writeln('File HEX and ASCII DUMP program Version'),
  writeln(version);
  writeln('Copyright 1985 by David W. Carroll');
  writeln;
  window(1,5,80,25); [PC-DOS]
ext := 256; [set initial .COM address]
window(1,5,80,25); [PC-DOS]
ext := 256; [set initial .COM address]

repeat
  ClrScr;
  write('Input filename --> ');
  readln(infname);
  if length(infname) > 0 then
    begin
      assign(infile, infname);
      [I-J reset(infile) {$I+};
      goodfile := (IOresult = 0);
      if not goodfile then
        begin
          write(chr(bell);
          writeln('FILE ' ,infname,' NOT FOUND');
          delay(3000)
        end;
      if not goodfile then
        begin
          write(' ');
          dat := 0;
          asciitext[call] := ' '
        end;
    end
  else
    quit := true;
  until goodfile or quit;

  if not quit then
    begin
      msec := trunc(sec / 65536.0);
      trans(msec);
      write(' ');
      sec1 := sec - (msec * 65536.0);
      hsec := trunc(sec1 / 256);
      lsec := trunc((sec1 - (hsec * 256.0));
      trans(hsec);
      trans(lsec);
      write(' ');
      for col := 1 to 16 do
        begin
          if not eof(infile) then
            begin
              read(infile,dat);
              trans(dat);
              if dat in [32..126] then
                asciitext[col] := chr(dat)
            else
                asciitext[col] := ' ';
            end;
          else
            begin
              write(' ');
              dat := 0;
              asciitext[col] := ' ';
            end;
    end
  if col = 8 then write(' ');
end;

This version of FILEDUMP is designed to operate on the PC-DOS version of Turbo Pascal 2.0b which includes windowing procedures. If the code lines marked {PC-DOS} are removed, the program will work under other versions of Turbo. You are encouraged to modify the program to your requirements. Some changes might include a printer output option, use of command line parameters, and display of one page of data (16 paragraphs of 16 bytes each) at a time.

This program and some 300 other Turbo Pascal public domain programs are available 24 hours a day for free by downloading from the High Sierra RBBS system at (209)296-3534.

David W. Carroll is a freelance writer and computer consultant living in the Sierra Nevada foothills near Sacramento, California. He is the author of "Telecommunications with the IBM PCjr" co-published by Microtext/Prentice Hall and "Programming with Turbo Pascal" to be co-published by Microtext and McGraw-Hill this summer.

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IMPLEMENTING SETS WITH BIT OPERATIONS

Sets with a small number of elements are easily implemented by bit operations in most languages. Some C compilers have a declaration `enum` that allows the programmer to use sets directly without worrying about the implementation. Unfortunately, most C compilers don’t have the `enum` construct. In any case, the implementations I will discuss allow more general uses than `enum` does, anyway.

Using bit operations we can implement sets, which in turn, specify such operations as: union, intersection, difference, assignment, membership, equal and size. The ordering relation can also be implemented, although, strictly speaking this is not a set operation.

SMALL SETS

A simple example of the use and implementation of a set is in the (BSD 4.2) UNIX select system call. `select()` takes parameters which represent sets of file descriptors. Since the number of files a process may have open is typically limited to 20, the set of file descriptors is easily represented by a 32-bit integer. Each bit then, designates a file descriptor. For example, if the set has an integer value of 25 decimal (or 11001 boolean), the file descriptors referred to are 4, 3 and 0 since the bits in the 4, 3 and 0 positions are on. In this example, the index of the bit is exactly the value of the file descriptor. However this need not be the case. What is important is the small number of elements.

For sets like the one above, which have no more elements than the number of bits in a single datum like an int, then we can use the following constructs for set operations:

```c
#define UNION: (1 <<)
#define intersection: (1 <<)
#define difference: (1 <<)
```

To declare a set, define it as an int (or whatever type you choose). I highly recommend using a typedef to make things more readable. Macros can also be used for the set operations themselves. For example:

```c
#define UNION: (1 <<)
#define intersection: (1 <<)
#define difference: (1 <<)
```

To define a one-element set, use the macro `#elt` with a small index representing the index of the element.

```c
#define elt(s) (1 << s)
#define member(s, a) (0 == (~elt(s) & a))
```

`min_elt()` returns the smallest index in a set (or -1 if the set is empty). These examples should be enough for you to write any other set operations you need using this representation.

```c
int min_elt(s)
{ int i;
  int x;
  for (i = 0; i < s; i++)
  { if (x == 0) return(-1);
    for (i = 0; i <= s; i++)
    { return(i);
  }
}
```

BIG SETS

This is fine for sets with a small number of elements, but what about larger sized universes? For example, if we are writing a device driver for a disk, we must maintain the sets of disk cylinders that are queued to be read and written.

A list of cylinders is a prime candidate for representation by a bit vector. The only real difference is that such a set is probably bigger than the number of bits in any data type on your machine. For example, suppose we have 100 cylinders and our largest data type is a 32-bit long. Then we would need 4 longs to get at least 100 bits for the cylinders (3*32 < 100 <= 4*32). To get those 100 bits, we can declare an array of longs. `#bigset` is a macro that does exactly that.

```c
#define bigset(name, bits) struct
#define SUBSET unsigned long

#define BITS_PER_BYTE 8
#define BITS_PER_SUBSET (BITS_PER_BYTE * sizeof(SUBSET))
```

This macro expands to a structure declaration! The structure defines an array of `"SUBSET"`‘s large enough to hold the set. We also define the number of `SUBSET`s in `"number"`, so that we won’t have to pass lengths as extra arguments into our set routines. `SUBSET` can be defined to be whatever is convenient for you. I always use “unsigned long” because the longer the datatype, the faster the routines will execute. For folks who watch every bit, though, shorter datatypes will waste less space (by leaving less unused bits at the end of the set array).

Finishing off `#bigset`, here are the macros needed.

```c
#define BITS_PER_BYTE 8
#define BITS_PER_SUBSET (BITS_PER_BYTE * sizeof(SUBSET))
```

Now we can declare sets for 100 cylinders to be read and written as:

```c
bigset(readcyls,100); bigset(writecyls,100);
```

In order to pass these sets as parameters, we’ll have to define a type for that. (Unfortunately, we can’t use `#bigset` for this because it defines a class of structures.) We do this as follows:

```c
struct bigset_param { int number; SUBSET data[1]; }
```

Most of the standard set operations (union, intersection, assignment, etc.) look very much the same. A single loop performs its respective operation on an entire `SUBSET` at a time.

Here is the code for union.

```c
bigset_union(s1,s2,s3) s1 = s2 U s3 ;
{ struct bigset_param s1, s2, s3;

  int i;
  for (i = 0; i < number; i++)
  { s1->data[i] = s2->data[i] UNION s3->data[i];
  }
}
```

To use this routine, of course, you must pass the address of the set.

`bigset_print()` requires an extra inner loop to print out each bit.
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Don Libes is a computer scientist working in the Washington, DC area. He works on artificial intelligence in robot control systems. He is also the son of Lennie and Sol Libes.
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Structured Programming With The Microsoft M80 Assembler

by Dennis N. Quinn

A conscious decision to implement a computer program using assembly language must be tempered with the knowledge that the assembler contains no elementary control structures to help the developer. Those structures which are often taken for granted in high-level languages are usually absent at the assembly-language level. For example, the Pascal language permits the following construction:

```pascal
if ('a' <= a) and (a <= 'z')
  then
    a = chr (ord (a) - 32);
```

Examination of the above code will reveal that the contents of the string `a` is tested in order to determine if it is in the range 'a' through 'z' inclusive; if so, 32 is subtracted from the ordinal position of the character in the underlying character set; the result is converted back into a character and replaces the original value in variable `a`. The net effect of this instruction is to convert the 1-byte contents of `a` to upper-case (assuming that this instruction is operating on a machine which uses the ASCII character-set).

### Use of certain language structures to control logic flow of assembly language programs

In assembly-language, this example becomes less easy to read (and certainly less easy to write). The same results as the above example can be obtained with the following assembly-language routine (Zilog mnemonics are used):

```assembly
a: defb 0
upshift: ld a, (a)
cp 'a'
jp c, ok.as.is
cp 'z'
jp c, shift.it
jr
nz, ok.as.is
shift.it: sub 20h
ok.as.is: ld (a), a
```

While the sequence written in assembly-language will undoubtedly execute faster than the Pascal example, most of the appeal of a structured language is its inherent readability. At times, though, the speed of assembly-language is required. What can be done?

### Control Structures

Most languages which support structured programming techniques provide the following five control structures as basic elements of the language:

1) The IF structure, which permits the testing of a boolean (i.e., true or
4) The REPEAT structure, which causes a set of instructions to be performed until a certain boolean value becomes false. The set of instructions, called the range of the structure, is executed at least once because the boolean value is not tested until the end of the structure.

2) The WHILE structure, which causes a set of instructions to be performed until a boolean value becomes false. The range of the structure is not executed at all if the boolean value starts out with the value false, because the value is tested at the beginning of the structure.

4) The CASE structure, which is similar to the IF structure except that more than two sets of instructions are presented, each associated with a certain value of the controlling variable. The set of instructions which corresponds to the actual value of the control variable will be executed and the remainder of the sets will be skipped. Many implementations of the CASE structure allow the user to provide a default set of instructions which will be executed in the event that the value of the control variable fails to match any of the specified cases.

5) The FOR structure, which is similar to the WHILE structure except that a control variable is initialized to a specified starting value, tested against a specified termination value, and (provided the termination value has not been exceeded) the set of instructions (the "range") is executed. At the completion of the range, the control variable is incremented by a specified value and the test is again made against the termination value. This process continues until the termination value has been reached or exceeded. Like the WHILE structure, it is possible for the range not to be executed at all.

With these five control structures, considerable power can be realized in the coding of a computer program. I have used the Pascal language since 1975 for most of my development, and I cannot recall a single instance where I felt the need for a GOTO verb.

When I purchased Microsoft’s F80, I did so because the first computer language I ever learned was FORTRAN and I felt a kind of nostalgic longing for the old language. Microsoft’s F80 is very similar to the General Electric GE-635 Fortran-64 I learned in college many years ago, and although the language immediately came back to me, somehow I felt uncomfortable using it. I greatly missed the language structures of Pascal, and I thought perhaps that the not insignificant investment I had made was a bad one.

Fortunately for me, Microsoft included the M80 assembler with the F80 compiler (primarily because the FORTRAN compiler produces assembly-language source as its output). I had done quite a bit of development with the Intel-8080 assembler, and I welcomed the opportunity to learn the Zilog Z80 instruction set and do some really powerful and fast programs in assembly-language. The only problem was that assembly-language has the same limitations as does FORTRAN — no structures for controlling logic flow!

Possible Solutions

Given that I wanted to write programs in assembly-language but that I also wanted to use control structures, what could I do?

Buy a C compiler: Most C compilers output assembly-language source code, and everybody knows that C is a magnificent language for producing excellent structured programs which are fast and efficient. Unfortunately, good C compilers produce mountains of assembly-language source even for a simple program. Couple that with the runtime support subroutines required, and C’s desirability rapidly falls off.

Write a custom compiler: While this might be an interesting solution, developing the type of compiler I would require to produce efficient assembly-language would not be a simple project. Even rudimentary compilers are extremely difficult to write, and heaven knows people have been trying since the earliest days of computers to design a compiler which could produce code as efficiently as a mediocre assembly-language coder. Besides, creating your own custom language is critical to the common pseudo-operation code* which associates a value with a symbol, DEF L. In this respect, it is identical to the common pseudo-operation code EQU; however, there is one small difference. Once the value of a symbol is set with EQU, it cannot be changed. The DEF L operation, however, allows the programmer to change the value associated with a symbol as often as needed.

Implementing the Solution

The Microsoft M80 macro-assembler has a pseudo-operation code* which associates a value with a symbol, DEF L. In this respect, it is identical to the common pseudo-operation code EQU; however, there is one small difference. Once the value of a symbol is set with EQU, it cannot be changed. The DEF L operation, however, allows the programmer to change the value associated with a symbol as often as needed.

*Actually, there are three synonymous pseudo-operation codes, SET, DEF L, and ASET. The SET code cannot, however, be used in the Z80 mode since there is an instruction with that mnemonic in the Z80 instruction-set. Since DEF L is the preferred Zilog pseudo-operation code, that name will be used throughout this document.
Why, then, would anybody use EQU if DEFL is so much more powerful? Well, for the same reason that programmers use constants in a program. Once a constant is identified as such, another programmer reading the program knows that the value will not be modified, while variables with a stated starting value could be changed, so the reader must be alert to possible changes to the value of the variable.

The DEFL pseudo-operation does for symbol values what variable-names in a program do for data-processing. And because the M80 assembler permits symbol names to be constructed by means of the concatenation operator ‘“&“‘, a pair of stacks could be incorporated into the assembly process which would permit the production of nested control structures.

Basically, there are two stacks, named ??STK.x and ??TYP.x (the x’s represent a decimal value 0 through 15). The question marks in the name were chosen so as to make the names of the stacks unique in the program. The programmer simply avoids coding any symbols beginning with a question mark, and he or she can be certain that no duplicate symbols will be created.

Another symbol, ??PTR, is used to keep track of the current place in the two stacks. ??PTR is initially assigned the value 0, pointing to the ??STK.0 and ??TYP.0 symbols. It is incremented when values are pushed into the stacks, and it is decremented when values are removed from the stacks. How these stacks are used will be made clear in a moment.

There are sixteen possible positions in each of the stacks, although this is an arbitrary limit. Since the implementation method used in generating code for the control structures (as the example I presented at the beginning of this article). Some means of continuing the condition testing over multiple statements must therefore be provided. Another complication is that the false-branch of the IF structure is optional; in this case, the mark which ordinarily identifies the beginning of the false-branch would be omitted and the ending mark must be taken to identify the end of the true-branch under these circumstances.

We should probably also take a minute to discuss the way the Zilog Z80 microprocessor handles comparisons. Two flags are significant in comparison operations, the Carry flag and the Zero flag. All comparisons are performed with unsigned 8-bit operands. In any comparison, there are three possible outcomes:

1) The two operands are equal. In this case, the Zero flag will be set and the Carry flag will be reset.
2) The accumulator is less than the other operand. In this case, the Zero flag will be reset and the Carry flag will be set.
3) The accumulator is greater than the other operand. In this case, both the Zero flag and the Carry flag will be reset.

If it is your intention to treat the two operands as signed 7-bit operands, you must test the signs of the operands before making the comparison. If the signs are the same, the comparison may be performed and the flags will be set correctly. On the other hand, if the signs are different, the Carry flag must be complemented after the comparison. You are responsible for ensuring that the Carry flag properly reflects the type of comparison you intended, since none of the control structure macros can determine the original signs of the operands once the comparison has been performed.

The IF structure: The IF structure has four parts: first, the statement of the condition which is to be tested; second, the mark which identifies the beginning of the false-branch; third, the mark which identifies the beginning of the true-branch (and, by default, the ending of the true-branch); and fourth, the mark which identifies the ending of the false-branch.

The IF structure is complicated somewhat by the possibility that multiple conditions must be tested (see, for instance, the example I presented at the beginning of this article). Some means of continuing the condition testing over multiple statements must therefore be provided. Another complication is that the false-branch of the IF structure is optional; in this case, the mark which ordinarily identifies the beginning of the false-branch would be omitted and the ending mark must be taken to identify the end of the true-branch under these circumstances.

As it was mentioned earlier, there are five macros which together implement the IF structure. Each will be presented individually.

WHEN — In their infinite wisdom and 20-20 foresight, Microsoft snatched up the “IF” mnemonic for their own use. That’s ok, though; WHEN works just fine and expresses the same thought. The WHEN macro introduces
the first condition test of the IF structure. It takes two operands; the first is required, and the second is optional.

The first operand expresses the actual condition desired. Rather than require the programmer to use the condition codes actually implemented in the Z80 hardware, the following condition mnemonics (in either upper or lower case) may be expressed:
eq or ze equality or zero (interchangeable)
eq or nz inequality or nonzero (interchangeable)
lt less-than
le less-than or equal
gt greater-than
ge greater-than or equal
cy carry flag set
nc carry flag not set
po or ov parity odd or no overflow (interchangeable)
pe or ov parity even or overflow (interchangeable)

The second operand is used to mark the fact that a compound conditional is desired. The value stated for the second operand must be in lower-case (an idiosyncrasy of the M80 assembler). Two values are permitted:
and If the current condition is true and the next stated condition is also true, execute the true-branch; otherwise, execute the false-branch.
or If the current condition is true or the next stated condition is true, execute the true-branch; if both stated conditions are false, execute the false-branch.

IS — The IS macro introduces the second (and subsequent) conditions in a compound condition of the IF structure. IS takes exactly the same operands as WHEN.

It should be pointed out here that if a compound conditional is expressed, the generated code takes its earliest possible exit to either the true or the false branch, testing no more conditions than are actually required to determine the truth of the conditional expression.

THENDO — The THENDO macro introduces the beginning of the true branch of the IF structure. This macro is always required and takes no operands.

ELSEDO — The ELSEDO macro marks the end of the true branch and the beginning of the false branch of the IF structure. This macro is optional; if omitted, the end of the true branch is marked by means of the EWENH macro.

EWHEN — The EWHEN macro marks the end of the IF structure. If a false branch was included, the EWHEN marks the end of the false branch; otherwise, it marks the end of the true branch. The EWHEN macro is always required and takes no operands.

The REPEAT structure: The REPEAT structure has two parts: first, the beginning of the range which is to be executed repeatedly; and second, the statement of the condition which must be satisfied in order for the loop to be terminated.

There are two macros which together implement the REPEAT structure. Each will be presented individually.

REPEAT — The REPEAT macro introduces the beginning of the range of the REPEAT structure. This macro is always required and takes no operands.

UNTIL — The UNTIL macro marks the end of the range of the REPEAT structure. This macro is always required and takes one required operand. The operand expresses the actual condition desired for termination of the loop. The condition mnemonics (in either upper or lower case) are the same as for the WHEN macro. Compound conditionals are not implemented for terminating the REPEAT structure since this feature is seldom required.

The WHILE Structure: The WHILE structure has two parts: first, the statement of the condition which must be satisfied before the loop will be executed; and second, the end of the range of statements which are repeatedly executed.
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There are two macros which together implement the **WHILE** structure. Each will be presented individually.

**WHILE** — The **WHILE** macro marks the beginning of the range of the **WHILE** structure. This macro is always required and takes no operands.

**The CASE Structure:** The **CASE** structure is a multi-way implementation of the **IF** structure and as such is somewhat redundant. Its usefulness, however, outweighs its redundancy, particularly where readability is important. There are four major parts in the **CASE** structure: first, the indication of the beginning of the **CASE** structure; second, the indication of the beginning of each of the select range groups and the associated value for that range; third, the indication of the beginning of the default range group; and fourth, the indication of the ending of the **CASE** structure.

There are four macros which together implement the **CASE** structure. The implementation of the **CASE** structure is unusual in that, while the other three structures assume that the programmer will perform the required comparisons prior to including the macro which tests the condition, the **CASE** implementation macros do all of the comparing for the programmer. Prior to coding the **CASE** structure, the programmer loads the accumulator register with the control variable; each of the select statements within the **CASE** structure then state a value which, if the accumulator contents matches the value stated, the range will be executed; otherwise, control will continue with the next select statement in the structure. Finally, if none of the specified values matches the value in the accumulator, the default range (if one is included) will be executed. The implementation of the **CASE** structure also automatically branches to the end of the structure after the code within the selected (or defaulted) range has been executed.

Graphically, this may be illustrated as follows:

```
        beginning of CASE structure
           first selector
               statement-1
               statement-2
               statement-3
           second selector
               statement-4
               statement-5
           default selector
               statement-x
               statement-y
           n-th selector
               statement-i
               statement-j
               statement-k
               statement-l
           third selector
               ...
```

Each of the four macros which implement the **CASE** structure will be presented individually.

**CASE** — The **CASE** macro introduces the **CASE** structure. This macro is always required and takes no operands.

**SELECT** — The **SELECT** macro terminates the previous select range
group and specifies the value which will select the following range group provided that value matches the value in the accumulator. There must be at least one SELECT macro for each CASE structure. The SELECT macro takes one required operand. The operand may be any of the following:

**(HL)**
This expression indicates that the HL-register pair points to a memory byte containing the value which is to be compared against the value in the accumulator.

**(IX+nn)**
This expression, where **nn** is a number in the range -128..127, indicates that the memory byte found at the address formed by the sum of the address in the IX-register added to the specified offset is to be compared against the value in the accumulator.

**(IY+nn)**
This expression, where **nn** is a number in the range -128..127, indicates that the memory byte found at the address formed by the sum of the address in the IY-register added to the specified offset is to be compared against the value in the accumulator.

**A**
This expression indicates that the contents of the A-register (the accumulator) are to be compared against the value in the accumulator. Because a match will always occur, this expression is trivial.

**B**
This expression indicates that the contents of the B-register are to be compared against the value in the accumulator.

**C**
This expression indicates that the contents of the C-register are to be compared against the value in the accumulator.

**D**
This expression indicates that the contents of the D-register are to be compared against the value in the accumulator.

**E**
This expression indicates that the contents of the E-register are to be compared against the value in the accumulator.

**H**
This expression indicates that the contents of the H-register are to be compared against the value in the accumulator.

**L**
This expression indicates that the contents of the L-register are to be compared against the value in the accumulator.

This expression, where **nn** is a decimal value between -128 and 255 inclusive, a hexadecimal value between 00 and FF, a symbol having a value in the same range, a single character enclosed in apostrophes, or a formula which will result in a value between -127 and 255 inclusive, indicates that the specified value is to be compared against the value in the accumulator.

If the expression coded as the operand of the SELECT macro contains any spaces, the Microsoft assembler requires that the operand be enclosed in angle brackets: `<expression>`...`endselect>`. The usual expression for this operand is a decimal or character constant, but the (**IX+nn**) and (**IY+nn**) expressions look like they could be used in interesting ways.

**DEFAULT** — The DEFAULT macro terminates the previous select range group and marks the beginning of the default range group. The DEFAULT macro is optional; if included, the statements in the default range will be executed provided none of the select ranges were executed. The DEFAULT macro takes no operands.

**ECASE** — The ECASE macro terminates the default range (if a DEFAULT macro was included) and marks the end of the CASE structure. This macro is always required and takes no operands.

**Using the Structures**
In order to use the structure macros described in this article, you should first build a file containing all of the macro prototypes shown in the accompanying listing. While that’s a lot of typing, you will have to type them only once. You can omit the comments from the macros as you type them in if you want to, which will cut down on the amount of typing you have to do (the comments can be identified by the appearance of a pair of semicolons — everything following the semicolons is a comment); keep this article around, though, in case you need to find out how a particular macro works.

Next, when you write an assembly-language program in which you want to use these control structure macros, include the .Z80 pseudo-operation code near the beginning of your module. (These macros generate Zilog mnemonics and use a few instructions which don’t exist on the 8080. The macros could be modified to generate Intel 8080 instructions instead of Zilog instructions, but that is left as an exercise for the reader.)

After the .Z80 pseudo-operation code, you use the INCLUDE pseudo-operation code* to bring the library into your module, then code the EASIN macro (no operands required) to produce the assembler symbols required for the other macros. (EASIN does not generate any executable code; all it does is declare the necessary symbols. It does not, therefore, have to be placed in an ‘executable’ part of your program. Just put it somewhere after the INCLUDE of the macros but before you begin using them.)

Now we get to the good part — actually using the control structures. For practice, let’s write our original example using the control structures, side-by-side with the assembly-language version:

<table>
<thead>
<tr>
<th>Original version in assembly-language</th>
</tr>
</thead>
<tbody>
<tr>
<td>a: defb 0</td>
</tr>
<tr>
<td>upshift: ld a, (a)</td>
</tr>
<tr>
<td>cp 'a'</td>
</tr>
<tr>
<td>cp 'c', ok.as.is</td>
</tr>
<tr>
<td>cp 'z'</td>
</tr>
<tr>
<td>jr c, shift:it</td>
</tr>
<tr>
<td>cp nz, ok.as.is</td>
</tr>
<tr>
<td>shift:it: sub 20h</td>
</tr>
<tr>
<td>ok.as.is: ld (a), a</td>
</tr>
</tbody>
</table>

**Same thing using structures**

| a: defb 0                             |
| upshift: ld a, (a)                    |
| cp 'a'                                |
| cp 'z'                                |
| when ge, and                          |
| is le                                 |
| thendo sub 20h                        |
| when                                 |
| ld (a), a                             |

Although the structured version is one line longer, the ability to use ‘ge’ and ‘le’ to express the conditions makes the code much more self-explanatory. Moreover, the proper use of indenting permits the subordinate nature of the subtraction to be clearly indicated. How about some other examples?

Here’s a sequence which you can use to copy a block of data from one place in memory to another. While the LDIR instruction is much faster, this

*As is customary with Microsoft, you can use INCLUDE, MACLIB, or INCLUDE interchangeably according to your personal preference.
exemplifies the use of a `REPEAT` structure:

```
d e, (hl);        ; Pick up 1st char to xmit.
d a, (de);        ; Get char to move.
push hl;          ; Preserve the pointer.
pop hl;           ; Get back the pointer
inc hl;           ; and bump it.
ld a, (hl);       ; Get next char.
and a;            ; and test it.
```

Here's an example of the `WHILE` structure, which sends a string to the CRT until a null (hex 00) character is encountered. Another macro, `SVC`, is used to invoke the CP/M BDOS function 6 for doing the actual character transmission. This example is written as a subroutine. Upon receiving control, the string to be transmitted is pointed to by HL. If a null string is received by the subroutine, nothing is sent to the CRT.

```
xmit:            ; Begin subroutine
    ld a, (hl);  ; Prime condition codes.
or a;            ; Put char into E,
while ne           ; and test completion.
    ld a, (de);  ; Get char to move.
    inc de;      ; Bump sending and
    dec bc;      ; receiving addresses.
    inc hl;      ; Decrement counter
    ld a, (hl);  ; and test completion.
or l;             ; All done - return.
    ret;        ; Return from subroutine.
```

For our last example, let's use the `CASE` structure to handle a menu. This would probably be the main processing loop of a program, so we'll throw in a `REPEAT` structure to handle the loop.

```
In our example, four typeins are permitted: "A" (upper or lower case), "B", "C", or "D", corresponding to routine A, routine B, routine C, and routine D respectively. If the operator types anything else, an error message will be displayed. Finally, the program terminates when the operator types control-C.

Conclusion
Anyone who has used a high-level structured language, such as Pascal, Algol, PL/1, or C, but who wants the speed afforded by assembly-language programming, can benefit from these macros. As can be seen from an examination of the coding examples, their use can greatly improve the readability of an assembly-language program, and the provisions for using mnemonic condition abbreviations such as "gt" or "le" simplifies debugging by improving the self-documentation qualities of the program.
```

I mentioned earlier that I would reveal how to increase the number of entries in the stacks should sixteen be insufficient. There are only three changes that must be made, all to the EASIN macro. First, change the constant in the `??STKL DEFL line to the desired value. Second, change the two IRP statements by including integers separated by commas after 1 and before the `"."'.

For example, if you want to increase the two stacks to twenty levels each, change the `??STKL DEFL line to `??STKL DEFL 20` and change the two IRP lines to `... ,15,16,17,18,19,20 >.``

---

**Dennis Quinn is an independent consultant specializing in microcomputers and office automation. He has been a computer analyst/programmer since 1965 and lives at 4114 Berkshire, Royal Oak MI 48073.**
BRNZ MACRO ADDR;;
  JP Z,ADDR;;
  ENDM

BRLT MACRO ADDR;;
  JP C,ADDR;;
  ENDM

BRNLT MACRO ADDR;;
  JP NC,ADDR;;
  ENDM

BRGT MACRO ADDR;;
  JP C,ADDR;;
  ENDM

BRNGT MACRO ADDR;;
  JP Z,ADDR;;
  JP C,ADDR;;
  ENDM

BRLE MACRO ADDR;;
  JP Z,ADDR;;
  JP C,ADDR;;
  ENDM

BRNLE MACRO ADDR;;
  JP Z,ADDR;;
  JP C,ADDR;;
  ENDM

BRGE MACRO ADDR;;
  JP NC,ADDR;;
  ENDM

BRNGE MACRO ADDR;;
  JP NC,ADDR;;
  ENDM

BRNC MACRO ADDR;;
  JP C,ADDR;;
  ENDM

BRNCC MACRO ADDR;;
  JP NC,ADDR;;
  ENDM

BRRC MACRO ADDR;;
  JP NC,ADDR;;
  ENDM

BRP MACRO ADDR;;
  JP PE,ADDR;;
  ENDM

BREPO MACRO ADDR;;
  JP PE,ADDR;;
  ENDM

BRPE MACRO ADDR;;
  JP PE,ADDR;;
  ENDM

BRNPE MACRO ADDR;;
  JP PE,ADDR;;
  ENDM

BRPE MACRO ADDR;;
  JP PE,ADDR;;
  ENDM

BRNPE MACRO ADDR;;
  JP PO,ADDR;;
  ENDM

BRPO MACRO ADDR;;
  JP PO,ADDR;;
  ENDM

BRNPO MACRO ADDR;;
  JP PO,ADDR;;
  ENDM

BRPE MACRO ADDR;;
  JP PE,ADDR;;
  ENDM

BRNPE MACRO ADDR;;
  JP PO,ADDR;;
  ENDM

BRPO MACRO ADDR;;
  JP ADDR;;
  ENDM

BRNUN MACRO ADDR;;
  JP ADDR;;
  ENDM

BR MACRO CCODE,TYPE,LABEL;;
  BR&CCODE ??&TYPE&LABEL;;
  ENDM

WHEN MACRO CCODE, ANDOR
  ??NEXT;
  ??AXEL ??FALSE, ??SYM;;
  ??STACK 1;
  ??NEXT;
  ??AXEL ??TRUE, ??SYM;;
  ??STACK 1;
  IFB <ANDOR>;;
  BR N&CCODE, 1, %??FALSE; ;
  ELSE;
  IFIDN ??NEXT;
  BR <ANDOR>, <and>;;
  ELSE;
  IFIN <ANDOR>, <or>;;
  BR &SADDR, 1, %??TRUE; ;
  ELSE;
  IFIDN <ANDOR>, <or>;;
  BR &SADDR, 1, %??FALSE; ;
  ELSE;
  IFIN <ANDOR>, <and>;;
  BR &SADDR, 1, %??TRUE; ;
  ELSE;
  IFIDN <ANDOR>, <and>;;
  BR &SADDR, 1, %??FALSE; ;
  ELSE;
  ERROR "** EXPECTED "end"|"or", ENCOUNTED "&ANDOR"";
  ENDIF
  ENDIF
  ENDIF
  ENDM
IS MACRO CCODE, ANDOR
??CLOSE 1;;
??DEFL ??TRUE, $??STK;;
??CLOSE 1;;
??DEFL ??FALSE, $??STK;;
??STACK 1, ??FALSE;;
??STACK 1, ??TRUE;;
IFB <ANDOR>;;
   BR &CCODE, 1, $??FALSE;;
   Pop true-branch name
   and save in $??TRUE
   Pop false-branch name
   and save in $??FALSE
   Push false-branch back
   Push true-branch back
   If <ANDOR> is null,
   Reverse-cond jump to false
   otherwise,
   IFIDN <ANDOR>, <and>;;
   If <ANDOR> = 'and'
   BR &CCODE, 1, $??FALSE;;
   Pop true-branch name
   and save in $??FALSE
   Pop false-branch name
   and save in $??TRUE
   Push false-branch back
   IFIDN <ANDOR>, <or>;;
   If <ANDOR> = 'or'
   Pop true-branch name
   and save in $??TRUE
   Pop false-branch name
   and save in $??FALSE
   Push false-branch back
   Error """"EXPECTED "and"|"or", ENCOUNTERED "&ANDOR"""
ENDIF
ENDM

THENDO MACRO
??CLOSE 1;;
??DEFL ??TRUE, $??STK;;
??LABEL 1, $??TRUE;;
ENDIF
ENDM

ELSEDO MACRO
??NEXT;;
??STACK 3;;
??LABEL 3, $??SYM;;
ENDIF
ENDM

EWHEN MACRO
??CLOSE 1;;
??DEFL $??STK;;
??LABEL 1, $??TRUE;;
ENDIF
ENDM

REPEAT MACRO
??NEXT;;
??STACK 4;;
??LABEL 4, $??SYM;;
??NEXT;;
??STACK 4;;
ENDIF
ENDM

UNTIL MACRO CCODE
??CLOSE 3;;
??DEFL ??TRUE, $??STK;;
??STACK 3;;
??LABEL 3, $??TRUE;;
ENDIF
ENDM

WHILE MACRO CCODE
??NEXT;;
??STACK 4;;
??LABEL 4, $??SYM;;
???NEXT;;
??STACK 4;;
??LABEL 4, $??TRUE;;
ELSE;;
   Pop statement block name
   Emit reverse-condition jump back
ENDIF
ENDM

EWHILE MACRO
??CLOSE 4;;
??DEFL ??FALSE, $??STK;;
??CLOSE 4;;
??DEFL ??TRUE, $??STK;;
??LABEL 4, $??FALSE;;
ENDM

CASE MACRO
??NEXT;;
??STACK 5;;
??STACK 5, 0;;
ENDM

IS MACRO CCODE, ANDOR
??CLOSE 1;;
??DEFL ??TRUE, $??STK;;
??CLOSE 1;;
??DEFL ??FALSE, $??STK;;
??STACK 1, ??FALSE;;
??STACK 1, ??TRUE;;
IFB <ANDOR>;;
   BR &CCODE, 1, $??FALSE;;
   Pop true-branch name
   and save in $??TRUE
   Pop false-branch name
   and save in $??FALSE
   Push false-branch back
   Push true-branch back
   If <ANDOR> is null,
   Reverse-cond jump to false
   otherwise,
SELECT MACRO VAL
??CLOSE 5;
??DEFL ??FALSE, ??STK;;
??CLOSE 5;
??DEFL ??TRUE, ??STK;;
??STACK 5, ??TRUE;;
IF ??FALSE;;
??STACK 5, ??FALSE;;
??STACK 5, ??TRUE;;
??LABEL 5, ??FALSE;;
CP ??FALSE;;
BR ??FALSE, ??STK;;
ENDIF;;
??STACK 5;
Pop next SELECT label
and save it in ??FALSE
Pop ECASE label
and save it in ??TRUE
Push ECASE label back
If not first time,
push SELECT label back and
emit jump unconditional to ECASE;
Otherwise,
generate label for next select and
put it into stack.

Pop this SELECT label
and save it in ??FALSE
Pop ECASE label
and save it in ??TRUE
Generate next SELECT label
and save it in ??SEL
Push ECASE label
Push next SELECT label
Emit label for this SELECT
Emit comparison against <val>
Emit jump not equal to next SELECT

Pop next SELECT label
and save it in ??FALSE
Pop ECASE label
and save it in ??TRUE
Push ECASE label back
If not first time,
push SELECT label back and
emit jump unconditional to ECASE;
Otherwise,
generate label for next select and
put it into stack.

Pop next SELECT label
and save it in ??FALSE
Pop ECASE label
and save it in ??TRUE
Push ECASE label back
If not first time,
push SELECT label back and
emit jump unconditional to ECASE;
Otherwise,
generate label for next select and
put it into stack.

Pop previous SELECT label
Pop ECASE label
Emit ECASE label

Emit load of BOOS code
E-register operand supplied?
Yes: Is it *(hl)?
Yes: Emit load through (hl)
No: Emit load into DE
Emit call of BOOS.
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One complaint that I hear frequently about FORTH is that it does not have local variables. These words were initially developed to prove that FORTH can indeed have local variables. Since they have been developed I find that they can be quite useful. When involved in the workings of some FORTH words the stack can be come quite cluttered and difficult to keep track of.

These simple words can do wonders for improving the readability of code. They also have the effect of saving memory required by FORTH standard variables for functions that have fleeting use.

These variables are dynamically allocated and deallocated from a predefined area. This area may be made only as large as the task requires. Probably the most unique thing about this implementation is the deallocation activation. One of the goals that I had was to make the use of these very simple and not require a programmer to do the cleanup. This goal was accomplished by extending the apparent end of the using word to perform the cleanup, by putting, on the return stack, the initial parameter field position returned to the stack. This causes the deallocation word to be executed after the end of the user word.

Screen 11 contains the words used in accessing the specific variables in the user's program. The real trick part, in this whole scheme, is the setting of the WIDTH variable to the value of the reference. The WIDTH variable is used in many FORTH systems to control the number of significant characters to retain in the word header, as words are compiled. The length byte is set to the number of characters in the name string at compile time. When the words are being compiled the length byte is used as the first comparison to decide if the names even need to be compared. If the length bytes match then the names are compared, character by character, until the last character is located.

Here is an example. The following sequence is executed:

```
I TEST1 1 • I
```

The header of TEST1 will be:

```
HEX
05 54 53 54 01
T E S T 1-- high bit set
1-- length byte
```

In the first case TEST1 will only match with TEST1, but in the next case a match will be found for any 5-character name that starts with "T". This implementation allows for each user word to define and access up to nine local variables, 1..9. If more variables are needed adding the following definitions would allow for 99 variables.

```
I 0XX (A) COMPILE 0 IMMEDIATE
I 1XX (A) COMPILE 1 IMMEDIATE
```

Screen 12 contains some test conditions that show how the words maybe used in a program. These routines may be used in any depth of nesting provided the stacks are sufficiently sized.

One note of caution for users of 6502-based systems, that use the processor's stack directly, the values (two 16-bit numbers) can quickly consume the full area.

REFERENCES

Thomas Reno is President of ONER SYSTEMS Inc., a software consulting company, located in Shoreham Vermont. He has been involved with FORTH for the last four years.
SCR # 9
0 ( LOCAL VARIABLES -1- vars, VARDEALLOT tr 03/23/85)
1 FORTH DEFINITIONS DECIMAL
2 0 VARIABLE LVSP (local variable stack)
3 100 ALLOT (area for stack)
4 LVSP 2 + LVSP! (init stack pointer is first cell)
5 : VARDEALLOT (---) deallocate previously allocated
6 7 LVSP ? (get current stack position)
8 R (get the value for the allocation)
9 - (deallocation of the space)
10 LVSP! (save updated stack position)
11 (---)
12
13
14
15

SCR # 10
0 ( LOCAL VARIABLES -2- VARDEALLOT tr 03/23/85)
1 : VARDEALLOT (vars ---) (allocate vars number of)
2 2 + DUP (convert to words & copy)
3 LVSP ? (get current stack)
4 + (allocate the space)
5 LVSP! (save updated stack position)
6 R (get the pointer from whence we were)
7 (called)
8 SWAP (get alloc count back on top)
9 R (put it on the return stack)
10 : VARDEALLOT (get address of dealloc routine)
11 R (put back our caller)
12
13
14 (---)
15

SCR # 11
0 ( LOCAL VARIABLES -3- ADDR, (A), @X, !X tr 03/23/85)
1 : ADDR (var# --- varaddr) (return address of the)
2 2 + (convert to word offset)
3 LVSP ? (get current stack base)
4 + (address of variable)
5 (A) HERE 1+ CONVERT DROP DROP (extract variable @)
6 [COMPILE] LITERAL (make it a literal)
7 COMPILE (ADDR) (dynamic part of name in name)
8 : WIDTH ! (set significant characters in name)
9 10 @X (--- value) (fetch contents of variable @)
10 (A) COMPILE @ : IMMEDIATE
11 1 X (value ---) (store value in variable X)
12 (A) COMPILE ! : IMMEDIATE
13 4 : WIDTH ! (restore significant characters in name)
14
15

SCR # 12
0 ( LOCAL VARIABLES -4- test cases tr 03/23/85)
1 : T1 (test verb cases 1)
2 1 VARDEALLOT (allocate 1 variable for this verb)
3 1 !1 (set it to a known value)
4 01 @X, U, CR (print it for operator to see)
5 6 1 TO (test verb number 2)
6 2 VARDEALLOT (allocate 2 variables for this verb)
7 2 01, 12 (set them to a known value)
8 10 11 (execute test verb !)
9 01, U, CR (verify values to user)
10 02, U, CR
11
12
13
14
15 (---)

SCR # 13
0 ( LOCAL VARIABLES -5- test cases tr 03/23/85)
1 : T3 (test verb # 3)
2 3 VARDEALLOT (allocate 3 variables for this verb)
3 00 11 (initialize them to known values)
4 200 12
5 300 13
6 02 T2 (execute test verb # 2)
7 01, U, CR (verify values to user)
8 02, U, CR
9 03, U, CR
10 01, 18
11
12
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14
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SOFTWARE REVIEW

PART I

Scientific & Technical Word Processors

By Steven Bosak

When I began my search for a scientific word processor just a few short years ago, I expected a glut of such software would be available. After all, my needs were tailor-made for a software solution: I wanted characters and fonts displayed on screen the way they would print, and an easy, fast method for entering technical and scientific characters and equations into the body of any text. I was, desparately, without, all of this to work in one seamless package.

Needless to say, I needed, wanted, and expected too much. At the time little was available, and most solutions were piece meal at best...solutions that were, in all practicality, no more efficient a manner of preparing technical manuscripts than the old reliable method of inserting the symbols by switching elements on a printer or typewriter.

As an alternative to that cumbersome approach, a number of character and font generators hit the market, promising one-step processor-to-printer routines. But there is a serious problem with this technique: printer codes must be inserted into the equations to properly support fonts and scripting levels. The result on screen is a jumble of control characters and commands mixed with the objects of the controls. This may work fine with simple equations, but once the scripting goes beyond one or two levels, I defy any technician to imagine what will ultimately roll out of the printer. It also makes format somewhat empirical, especially when overprinting is required.

When the average memory began to exceed the 64K barrier, possibilities suddenly presented themselves, giving rise to a new breed of technical word processors. The additional memory was used to generate technical, Greek, and math symbols on screen. High-speed dot matrix, ink-jet, and laser printers, capable of integrated letter AND high quality graphics, made possible fast and professional-looking technical and scientific word processing systems.

These new software products differ greatly in features, performance, and price. If you deal with technical or scientific manuscripts and want an overview of the latest and greatest available for microcomputers, the following evaluations will give you a good idea of what program might suit your particular needs. I have eliminated from review a great number of programs that I felt were confined to a narrow market, for example programs limited to one computer and printer or those which are simply a variation on the old thimble-juggling routines of the past as well as packages which are not fully integrated. As a technical editor and consultant in this arcane field of symbol and script scribbling, I've come to form very definite ideas about what the "perfect" technical and scientific word processor should do for the user.

The guidelines and requirements I used to examine these products are:

* The software should run under MS-DOS. Like it or not, this is the defacto DOS standard for office and personal computers.
* "What you see is what you get"...No surprises, please. If I have a five-level equation with large curly brackets, that's what I want to see on screen AND, of course, coming out of the printer.
* High-speed, letter-quality, dot-matrix, ink-jet, or laser printers should be supported. Yes, you CAN use double-thimble, daisy-wheel printers, but in my experience, they are noisy, slower, and no matter which thimble or wheel I choose, there is always another character on yet another thimble that I need. Why not let the software and versatile hardware do the job? Double-thimble, daisy-wheel printers just seem to be one cut above switching the elements on a Selectric III.
* The systems should be just that--systems. All the parts, if they are even discernible as such, should work in harmony.
* The processors should be easy to grasp. This is, perhaps, one of my most obvious but essential requests. A good technical and scientific word processor will be used by many people--from the head of the department to a member of the typing pool. Let's face it, most of the technical typing is done by the secretaries and administrative assistants. By asking that the packages be easy to use, I am not discounting their ability to grasp a complex program, but merely pointing out the reluctance on the part of most professional typists to put up with a grudging and cumbersome system that hampers their productivity. I cannot blame them in the least, and in my work as a consultant, their concerns are very often the bottom line.

In these evaluations I used a Zenith Z-151 PC with 640K RAM and two floppy disk drives. The Zenith video board displayed all the programs admirably--I didn't have a hitch with any graphics. For printing, I used Toshiba's new P351, an improved and faster version of their 1351 24-pin dot matrix printer. The print quality was letter perfect and the speed incredible--over 100 cps in letter-quality mode, and over 200 cps in the draft mode! All print samples in this article are from the P351.

VOLKSWRITER SCIENTIFIC

Lifetree Software, Inc. has been in the word-processing business a number of years. Their Volkswriter and Volkswriter Deluxe are solid and popular word processors. If you currently use either of them in your office or at home, then Volkswriter Scientific should be the first of the technical word processors to consider. You will find many familiar or very similar commands. In addition, Volkswriter Scientific imports Volkswriter Deluxe files for conversion to the VW Scientific format. (Other text files can be imported also.)

INSTALLATION: The program was simple to install-you merely execute a batch file for installation on either a floppy or hard-disk system, a process that took all of two minutes. VW Scientific was then ready to run.

FEATURES: The opening menu provides you with either print, retrieve, directory, create new document or exit options. After retrieving or opening a new document you are brought to the Format Menu. Here you have the option of setting defaults, modifying the existing parameters, or accepting
the existing defaults and continuing on to the actual processor. Among the format features that are set at the menu are line spacing, left and right margins, hyphenation, large or small font size, and tab stops.

Next is the processor. If you wish to edit an existing document, you are given the time-saving prompt “Which page to start?”. The document comes up with a menu of menus along the bottom fourth of the screen. The F1 function key followed by numbers 1 through 9 bring up separate menus for cursor movement, microspacing and justification, footnoting, and use of Greek, script, mathematical, scientific, and engineering characters. Each menu pops up along the bottom fourth of the screen when called, so you always have a portion of your working text on screen.

Entry of text is straightforward. The processor has all the standard editing and formatting features of the common word processor, i.e., word wrap, reformatting, insertion, deletion, simple keystroke commands for rapid movement within the text, as well as commands to cut, paste, and unerase. Cursor movement is in full spaces, half spaces or even microspaces. This micropositioning is great for aligning subscripts, superscripts, or elements within an equation.

Technical symbols are entered with two keystroke commands that, in most cases, parallel their standard character cousins. For instance “\ a” enters an alpha, “\ b” beta, and so on. The menus for the symbols show “type this” in one column “to get this” shown in the neighboring column. The symbols are logically arranged and easy to choose from the screen. In addition to the 400-plus characters and symbols provided, Volkswriter Scientific has a macro-key feature—any of 26 (Alt.-A through Alt.-Z) keys can be used to define a series of keystrokes. The macro keys, in conjunction with VW’s building-block font set, allow the creation of custom chemical chains, brackets, square root, and parentheses, which can be easily recalled. A number of large bracket and brace sets are already defined with the initial package. I found creation and storage of new sets easy to accomplish, as long as cursor movement suggestions, as provided in the documentation, were closely followed.

Additional comforts provided in the VW Scientific font sets are true footnote-sized numerals, foreign symbols, and general characters such as pound, cent, paragraph and copyright. Boldface, underline and italics are just one keystroke away.

DOCUMENTATION: Provided with Volkswriter Scientific is an interactive tutorial disk which takes the user through the easiest to most complex aspects of the program. I strongly advise anyone, regardless of sophistication, to go through this tutorial. It is thorough and gives plenty of opportunity to use the features as they are being explained. In fact, after completing the disk tutorial, I merely used the documentation as a reference.

PRINTING: Printing a document with Volkswriter Scientific requires closing out the document, going back to the main menu, and choosing PRINT. Once in the printer menu, you are given the option of changing standard printing parameters such as model of printer, number of copies. Alternatively you may simply enter a RETURN to use your pre-set defaults. Once I had the Toshiba P351 set in unidirectional mode, the processor and printer worked together perfectly.

FINAL CONSIDERATIONS: Despite VW Scientific’s merits, it could stand some improvement. For one thing, the print speed, even with the P351, was slow. This is due, I’m sure, to VW Scientific’s unidirectional printing as well as the method of operation; each page is graphically mapped. A Ctrl-F8 is needed to create each new page of text. The program tells you when the current page is filled. It then goes out and initiates that new page for mapping. On a floppy-disk system this is a bit annoying. A RAM disk and a print spooler alleviated these problems to a tolerable level. If you deal with longer manuscripts, I would strongly advise that you get a hard disk-mapping the pages in this manner eats up disk space.

Still another drawback is the inability to add fonts or font sets or to modify the existing characters. If you deal with a number of irregular or customized characters, you should check the sets that are in the program before purchase to see if VW Scientific will meet your needs.

SUMMARY: VW Scientific was, without a doubt, easy to set up and use. If you want standard mathematical, Greek, engineering or scientific characters, and need to see your work displayed exactly (and I mean exactly!) on the screen as it will print out, this may be the package for you. The system runs well on a 256K double-disk drive PC, but as I said, if speed is a concern, or you are working with longer manuscripts, I would recommend use with a RAM disk and a small print buffer or a spooler and hard disk.

T3

T3 by TRIAD Computing Inc. is a feature-loaded system. In fact, the entire program comes on three disks, all of which are needed for operation. Minimum RAM requirement is 512K—more is recommended. It can be run on a floppy system, as my experience has shown, but a hard disk is really essential to get any use out of this processor. Anything less does the program a disservice.

INSTALLATION: Installation, via one main batch file, was relatively painless. You’ll experience some vertigo, however, when you attempt to install a printer not supported by the hard disk—read the logo carefully. I was assured that the program was itself and “attach” the newly installed printer to the running program, otherwise the new printer driver is not recognized when you attempt to print a document and will default to the IBM GRAPHICS. The people at TRIAD assure me that this extra step to the printer installation will soon be eliminated.

When executed, the program loads an incredible amount of material—system volumes, font sets and drivers, as well as program overlays. On a floppy system this takes a great deal of time, a hard disk is definitely the way to go. T3 allows multiple users and password

Quick Reference

PRODUCT: Volkswriter Scientific LifeTree Software Inc. 411 Pacific Street Monterey, CA 93940 (408) 373-4904

SYSTEM REQUIREMENTS: MS-DOS 2.x or higher on an IBM PC or compatibles. IBM color graphics adapter or any compatible video cards. A minimum of 256K RAM and two floppy disks. Additional RAM for spooler and RAM disk operation, as well as a hard disk, desirable for long manuscripts or heavy use.

PRINTERS SUPPORTED: HP Thinkjet, Epson MX, FX; Toshiba 1340, 1350, 1351, P351; NEC 8023A; ProWriter; IBM Graphics Printer

PRICE: $495.00 includes system and tutorial disks with documentation.
past the start-up, you are presented with protection. Users can have their access font sets, etc. Of course, all the expected options—print, create a new document and revise documents—are also present.

**FEATURES:** T3 has the typical word processing features, i.e. word wrap, reformatting, tab and margin settings, cut and paste, search and replace, footnotes and headers, easy text entry, and cursor movement. All text and equations are entered in the same manner, so there are no modes to switch. Functions are selected via pop-up menus or keyboard commands. Manuscript formats or templates can be set or reset and stored for easy retrieval. Key sequence macros can also be stored.

Full- and half-space cursor movement create true super and subscripts on screen. A nice feature of T3 is that it treats equations as single line entities, reformattting will not "dissolve" your work or break up lines, the equation will hold together. As a bonus, standard ASCII files can be imported to the T3 format.

T3 handles technical and scientific characters as well as other symbols through alternate keyboards. These keyboards—up to seven, in fact—can be attached to any given manuscript. When text is entered on the normal keyboard, one of the available keyboards is selected at the alternate, while the remainder attached but not usable until rotated into the alternate slot. If a keyboard, let's say the Greek, is designated as the alternate, all keys on the keyboard—both upper and lowercase—produce Greek characters when pressed with the Alt. key. Similar to VW Scientific, T3 has made such key assignments as logical as possible (Alt.-a for alpha, etc.). You can view the alternate keyboard at any time by pressing Shift-F8—the alternate key, lower/uppercase, will pop-up on screen.

If you would rather avoid using the pop-up keyboard, you can print it out for reference by hitting the Shift-PrintSc keys. (See Figure 1) To get an alpha character into my text, I simply hit Alt.-a provided the Greek keyboard is my alternate. If I want to use a character from any other keyboard, it must be designated as the alternate. Better make sure the keyboard you choose as the alternate has the characters you are most likely to use.

One of T3’s better character/font features is the ability to create your own custom keyboards. If you rarely use a character and find that you need a different character from another keyboard, you can delete, through a menu-driven Revision program, the unwanted key and insert any other defined key in its place. Individual characters, while on a grid, can also be modified, or entirely new characters created!

**PRINTING:** Documents are printed after selecting "Send to printer" from a prompt at the end of an editing session or from the "Print" option under the DOCUMENTS menu. All the formatting is taken care of in your manuscript defaults and through the installation of the printer. T3, like VW Scientific, is bit-mapped. Exactly what is on the screen is printed. There are no surprises.

The only hassle with printing involves the unique manner in which T3 handles this bit-mapped printing. Each document is created inside a "shell". If pages are not determined and marked explicitly in the text, or if they are entered and the text is then reformatted, results can be interesting to say the least. Best to follow the documentation’s advice and insert your page determinations or breaks only AFTER your text is ready for a FINAL print.

**DOCUMENTATION:** T3’s documentation, like the program itself, is large. It could also stand for some thoughtful reorganization. After spending time on the program’s installation, the documentation sends you to the end of the long tutorial. Sections on creating new document shells and formats are scattered throughout. The printer installation section is, similarly, off on its own, buried between KEY SEQUENCES and VOLUMES for some reason.

The on-disk tutorial was a better place to get acquainted with T3 than it’s documentation. A variety of sample files, from simple letters to manuscripts containing multi-level equations and benzene ring chemical chains are provided to illustrate how to use T3’s features.

**FINAL CONSIDERATIONS:** Despite T3’s power and versatility, there are a number of things I dislike about the program. For one thing, even barring the password provisions, there are just too many features that need to be set. You have to set a “Face” key for either bold or underline—it has to be either/or—not both!). You have to set shells up. You must attach printers and manuscript formats. You even have to set your own "Profile" which carries some of the above preferences and defaults and attaches to you when you enter the program and sign on. Also, for some reason I’ll never understand, on the command level all instructions are terminated with the “+” sign from the numeric keypad. Why not RETURN, like every other piece of software known to man?

Errors and error messages are not adequately explained on the screen or in the book. When I inadvertently booted T3 without the correct CONFIG.SYS file on disk, the resultant error message was anything but informative, and actually quite misleading. Nor did the documentation do anything to help extricate me from my misfortune. Fortunately, TRIAD has a toll-free support number to call.

**SUMMARY:** You’ll have to spend time getting used to this system. T3 doesn’t approach word processing in the same manner as most programs, so it takes quite awhile before you feel comfortable with T3’s idiosyncrasies. (The “Face” key and “+” entry on command level were my biggest gripes.) The chemistry and font-editing facilities make it especially useful to chemists, chemical engineers and people that require customizable characters and keyboards.

This software is not effective on a two-floppy system, except for short manuscripts. I would set 640K RAM and a hard disk as the minimum system configuration. With its sign-on and password features, T3 would be well suited for a multi-user environment that
 Idolising: Installation is moderately taxing, and involves a bit of disk swapping. To get the proper character set loaded and your printer installed, you have to go through at least four disks. But once installed, you are set: the system disk and alternate character sets need never be re-installed unless you have a need for entirely different sets. Printers were installed from a very complete menu, and was no more complicated than punching the correct number. Like T3, unusable characters could be replaced by characters from other font sets. Each character could also be edited on a cursor-addressable 24x24-pixel grid. Completely new characters can also be created in this manner.

**FEATURES:** I mentioned Proofwriter's word-processing skill—it really is a nifty, little, FAST word processor. I only wish the creators had used as much care in endowing the rest of the program with such speed and ease-of-use. To start, those wondrous alternate character sets are buried in keyboard after keyboard. You have to be in an "alternate" mode to pick from these keyboards. The only way around this "mode" is to enter the characters directly to the screen using their assigned ASCII value with the Alt. key. To get an alpha, you would need to know it had been assigned to ASCII number 155 and enter: Alt. 155. Luckily there is a provision for printing out this table, so you can look up the characters. (see Figure 2) It beats calling up the many pop-up keyboards to find your character, re-entering the text, switching to the correct alternate keyboard and THEN entering the (by now forgotten) character. Proofwriter should allow assignment of a first alternate character set during the installation rather than having the many alternate boards.

To further complicate these matters, the text processor itself has Insert, Change, and Command modes. Macros for the creation and storage of large braces, brackets or other multi-line symbols is hinted at on pages 3-44 to 3-45 of the manual. I am not sure if such construction and retrieval is possible. I ended up building each bracket I made from scratch.

Another feature glaringly absent from Proofwriter was the ability to see directly on the screen what would end up on the printer. You saw "kinda" what would end up on the page. The LEAST annoying omission in this regard, was the representation of half lines as full lines on screen. A line-space shift command would tell the printer to change the line spacing. Within the text, subs and superscripts were indicated by highlighting the "offending" script... unfortunately, the highlighting does not indicate if the character is sub or superscript.

More offensive to the typist was Proofwriter's inability to show-in the editing environment--the way that equations would end up once they were sent to the printer. To get such a preview, you have to leave the editor, go to the print menu and select "View" to see the actual results of all your editing. Not nice. The differences can
Super assemblers plus the world's largest selection of cross assemblers!

Z-80
Macroassembler
Power for larger programs! This 2500AD macroassembler includes:
- Zilog Z-80 Macroassembler (with the same powerful features as all our assemblers)
- powerful linker that will link up to 128 files. Com files may start at any address
- Intel 8080 to Zilog Z-80 Source Code Converter (to convert all your Intel source to Zilog Syntax in one simple step)
- COM to Hex Converter (to convert your object files to Hex for PROM creation, etc.)
- 52 page User Manual

8086/88 Assembler with Translator
Available for MSDOS, PCDOS, or CPM/86! This fully relocatable macro-assembler will assemble and link code for MSDOS (PCDOS) and CPM/86 on either a CPM/86 or MSDOS machine. This package also includes:
- An 8080 to 8086 source code translator (no limit on program size to translate)
- A Z-80 to 8086 translator
- 64 page user manual
- 4 linkers included:
  - MSDOS produces .EXE file
  - CPM/86 produces .CMD file
  - Pure object code generation
  - Object code and address information only
Linker features:
- Links up to 128 files
- Submit mode invocation
- Code, Data Stack and extra segments
- Handles complex overlays
- Written in assembly language for fast assemblies.

Z-8000 Cross Development Package
Instant Z-8000 Software! This package allows development and conversion of software for the Z8001, 8002, 8003 and 8004 based machines on a Z-80, Z-8000 or 8086 machine. This powerful package includes:
- a Z-80/8080 to Z-8000 Assembly Language Source Code Translator
- Z-8000 Macro Cross Assembler and Linker
  The Translators provide Z-8000 source code from Intel 8080 or Zilog Z-80 source code. The Z-8000 source code used by these packages are the unique 2500AD syntax using Zilog mnemonics, designed to make the transition from Z-80 code writing to Z-8000 easy.

Assembly Time Calculator—will perform calculations with up to 16 pending operators using 16 or 32 Bit arithmetic (32 Bit only for 16 Bit products). The algebraic hierarchy may be changed through the use of parentheses.

Include files supported—Listing Control—allows listing of sections on the program with convenient assembly error detection overrides, along with assembly run time commands that may be used to dynamically change the listing mode during assembly.

Hex File Converter, included—for those who have special requirements, and need to generate object code in this format.

Cross reference table generated—Plain English Error Messages—System requirements for all programs: Z-80 CP/M 2.2 System with 54k TPA and at least a 96 column printer is recommended. Or 8086/88 256k CP/M 86 or MSDOS (PCDOS).

Cross Assembler Special Features
Z-8—User defined registers names, standard Zilog and Z-80 style support. Tec Hex output option.
8748—standard Intel and Z-80 style syntax supported.
8051—512 User defined register or addressable bit names.
6800 Family—absolute or relocatable modes, all addressing modes supported. Motorola syntax compatible. Intel Hex or S-Record format output.
6502—Standard syntax or Z-80 type syntax supported, all addressing modes supported.
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Company ____________________________
Address ____________________________
City __________________ State ______ Zip ______
Phone ____________________
Make and model of computer system __________________
□ COD (2500AD pays COD charges)
□ VISA or MasterCard
Number __________________
Expiration Date ____________________

TO ORDER. Simply circle the product or products you want in the price columns, and add up your order.

Total $________

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be astounding. An equation that looked great on screen came out as garbage when printed. Other users have experienced "phantom" characters in final printouts. As I said, you can check the equations, but this requires many extra steps—think of a document with dozens of equations!

DOCUMENTATION: The documentation was a joy to behold—a full-page, 8 x 11 inch book that would lay flat, was easy to read and stuck to the step-by-step essentials. The only problem I had was with the mixture of Proofwriter Graphics and International documentation. On a number of occasions, I found myself reading sections intended only for the International user. Perhaps these sections could be better segregated or marked? All the sets of available fonts were listed in back, as well as a genuinely useful index.

PRINTING: Printing is a painless and quick experience. Because Proofwriter does not depend on bit-mapping each page, its speed was tremendous. It was the one program that fully utilized the Toshiba P351's speed and quality. What you pay for here is the speed, which you lose on the screen. Similar to WordStar, Proofwriter has a slew of printer codes for formatting and customizing each page, and even each paragraph.

FINAL CONSIDERATIONS: Proofwriter is a copy-protected program. I don't know how you feel about such matters, but I have a personal boycott in effect on such products. I don't allow any copy-protected program in the same system with my valuable text and data files. I have no idea why the folks at Image Processing Systems chose to go this route.

As I said earlier, this is a fast text processor with extensive character sets and optional character creation. If the on-screen-to-printer discrepancies and
SCIENTIFIC WORD Processors continued from page 46.

mode-shifting could be eradicated, this may well be a great product. Presently, it isn’t very suitable for manuscripts with extensive sub and superscripting levels or numerous equations. There is no support for the creation and storage of chemical symbols.

SUMMARY: If you don’t mind the extra pain and effort needed to “check up” on your equations between edit and print time, and you need a fast processor with a spelling checker, this is a good system. Because Proofwriter doesn’t map out each page, it can import any standard ASCII file without a “special utility” for doing so. This may be THE system for those that have relatively light technical and scientific references and who want a good word processor to boot. The alternate character sets are among the most extensive I’ve seen—15 sets at approximately 128 characters per set! This may be the only system that would allow extensive foreign and technical fonts to be easily inserted into text.

Steven Bosak lives in Evanston Illinois and is a freelance writer/editor who has worked on everything from technical writing to fiction. His novel, titled “Gammon” has just been published by St. Martins/Marek Press.

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The Macrotech MI-286

by Charles Strom

For several months, we have been working with several MI-286 CPU boards from Macrotech International. Always looking to improve throughput in leading-edge, multi-user, multi-tasking systems, Macrotech engineers have designed a board from the ground up to be plug-compatible with the CompuPro 8085/88 dual-processor board. This meant hardware and software compatibility, and therein lies a tale to be explored later in this article. The CompuPro 8085/88 board is a popular CPU board, due in large part to the reliability of hardware as well as the advanced technical features built into the CompuPro line allowing DMA transfers, interrupt-driven operation, etc.

A strong point in the design is the 8080-compatible processor on board. It is a simple matter for the user to insert a CP/M 2.2 disk, if desired, or change to a sixteen bit operating system such as CP/M-86, MP/M, MP/M 8-16, or Concurrent-CPM merely by inserting the appropriate boot disk. The beauty of MP/M 8-16 and other 8/16-bit operating systems, is that the user can transparently run virtually any CP/M-80 program. This is performed by automatic invocation of a utility which transfers control of the actual program to the eight-bit processor while funneling all operating system calls through to the sixteen bit chip.

Macrotech recognized the value of this scheme and decided to bring the concept of the 8085/88 board up to date.

THE EIGHT-BIT PROCESSOR

The eight-bit chip is the Z80H running at 8MHz, as opposed to the standard Z80 4MHz clock speed so common in the many eight bit machines produced today. There are extant a few proprietary programs that depend on the Z80 for operation, and many more public domain programs that use relative jumps, for example, and therefore crash on an 8085. Now we can run these utilities without incident.

Gifford has even upgraded their SW.CMD (the "switch" program which is used to enable an eight-bit program to run under Gifford’s MC-DOS) to support the extra registers of the Z80. What’s more, the Z80H at 8MHz operates significantly faster than the 8085 at 5MHz on the older CompuPro board. There is 100% compatibility between the CompuPro and Macrotech boards in eight-bit operation as far as we can determine, except, of course, for the additional functionality we have gained through acquisition of a Z80 rather than an 8085. However, a program using the 8085 RIM and SIM (Read Interrupt Mask and Set Interrupt Mask) instructions, would not operate correctly (but we have never run across such a program).

There are several options available that configure Z80 operation. They include a choice of the default 8MHz operation or optional 2MHz operation for time-critical applications, Z80 reset on processor swap (when Z80 regains control after 80286 relinquishes control), and several wait-state generator options. We will discuss the latter along with the 80286 wait-state options below. Let it suffice to say that the Z80 side of the MI-286 operates as a perfectly domesticated eight-bit CPU board in all applications we have tested. Several representative benchmarks comparing the Z80H operation to equivalent 8085 tasks appear below.

THE SIXTEEN-BIT PROCESSOR

I will devote considerably more space to a description of the 16-bit personality of the MI-286 processor board. The basic computational power is supplied by an Intel 80286 chip running at 6MHz. The 80286 is a state-of-the-art 16-bit processor. The basic set of registers, instructions and addressing modes are upward compatible with the 8086, 8088 and 80186 CPU’s. Programs written for these CPU’s will run unchanged on the 80286. Intel specifies clock rates of 4, 6 and 8MHz available for the 80286 in the preliminary datasheet, but 8MHz parts are not yet generally available and Macrotech is offering their board only with the 6MHz part.

The 80286 two basic operating modes, real address and protected virtual address. The chip’s default mode is real, permitting direct addressing of one megabyte (a 20-bit address field). The details of the real addressing mode are nearly identical to that of the earlier Intel 16-bit chips so that all operating systems running on the 8086 or 8088 will operate without modification with the 80286. An exciting future growth path involves the protected virtual address mode. The protected mode offers one full one gigabyte of virtual address space mapped into 16 megabyte physical address blocks through a full 24-bit physical address field. In addition, the protected mode prevents critical instructions from affecting the CPU’s execution, restricts writing to certain memory segments, and has a hierarchical system of task priorities.

Digital Research is reportedly designing a piece of software, called Concurrent DOS-286, which will operate with the 80286 and make full use of the protected mode of operation thus supporting a much-improved multi-user, multi-tasking operating system. Unfortunately DRI seems to have a penchant for changing the name of their product on a monthly basis so this operating system will most likely be known by another moniker by the time it is released! The above-mentioned modes will allow a multi-user system to operate without crashing in the midst of a renegade application program. But not knowing anything concrete about this DRI project I cannot really make any significant pronouncements, though I do know our MI-286 is all ready to use it.

Some other 80286 features include 64K 8-bit (or 32K 16-bit) I/O ports, a six byte instruction prefetch queue, and pipelined addressing. The latter supports overlapping instruction fetches, instruction decoding and improved execution to increase processing throughput. Not being a microprocessor engineer, I do not feel competent to make a comparative analysis of the 80286 with respect to
other state of the art chips such as the National Semiconductor 16032 or Motorola 68000 families. However, it appears to me that the 80286 is an excellent choice of a processor that offers 100% upward compatibility with previous Intel chips, allowing me to run my current operating systems software without modification. In addition, I am looking forward to using the protected mode feature when the software becomes available.

**MI-286 BOARD OPTIONS**

There are a host of options on the board. Memory management control can be set as shown in table 1:

**TABLE 1**

<table>
<thead>
<tr>
<th>Mode</th>
<th>Processor A23-A20/A19-A16/A15-A0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (default)</td>
<td>Z80 latch latch direct</td>
</tr>
<tr>
<td>1 (virtual)</td>
<td>Z80 latch latch direct</td>
</tr>
<tr>
<td>2 (286 primary)</td>
<td>Z80/286 latch direct direct</td>
</tr>
<tr>
<td>3 (Z80 primary)</td>
<td>Z80 latch latch direct</td>
</tr>
</tbody>
</table>

Direct control of the upper address line refers to the existence of real address lines, while latched control involves writing data to the memory management port. The memory management port can be optionally cleared on reset. Mode zero sets up the process to be equivalent to the CompuPro 8085/88 addressing scheme, while mode one will presumably be used for Concurrent-286.

**WAIT STATE SELECTION**

Little did I realize when I received the first beta-test MI-286 board that the subject of wait state selection would consume so much of my attention. The Z80 wait state jumpers are flexible, permitting optional choice of one I/O, memory, and/or M1 wait. Our system operates properly with the factory default setting of no memory waits, having one I/O and one M1 wait state inserted for the Z80H. The 286 is a far more complicated proposition. Jumpers allow for zero through three wait states to be inserted for I/O and memory operations. Obviously, a primary design goal was to permit high speed operation (without 80286 waits) using CompuPro memory boards. Unfortunately, Macrotech developed their CPU board using their own 512K static memory board and had few problems in this area. They also tried some CompuPro boards from a nearby client's system, and true to Murphy's law, experienced no problems there either. But upon receipt of the original board, we were unable to operate our CompuPro RAM 16's or RAM 21's without inserting two memory waits. This slowed down the system to a speed which was unacceptable to Macrotech. After several weeks of labor, Macrotech engineers discovered a bug in the current version of the 80286! To paraphrase Intel's 80286 errata sheet of 22 May, 1984, if the 80286 executes a POPF (pop F) instruction, a pending maskable interrupt may be improperly recognized even if maskable interrupts were disabled before the POPF instruction and the value popped had IF=0. In an interrupt-driven operating system such as MP/M 8-16, this would be disastrous as indicated by randomly produced "Panic! Interrupt" messages. On the other hand, no such problem was encountered on non-interrupt-driven systems.

Intel's suggested fixes included recoding to eliminate POPF instructions. This is impossible since the MI-286 was designed to drop into an existing system with existing hardware and software. Another suggestion was insertion of two wait states. The latter fix, which we observed to operate effectively on our system, was also unacceptable because of the cost in speed. After considerable research, Macrotech determined that insertion of two wait states for every memory data read operation only would be the best compromise at this time. Thus, there is a special jumper for this operation on the current revision of the circuit board. The cost of this speed was determined by a compute-bound benchmark which decreased from 2.5 to 2.3 with use of the jumpers. Therefore, we are paying a worst-case price of 12% by inserting these waits.

**MORE JUMPERS**

There are a host of other jumpering options including reset options for both processors, 16/24 bit DMA addressing, MWRT enable, power-on-jump address selection, I/O base address selection, etc. There are four I/O ports defined for processor swap, memory manager address specification, and memory management mode control. Lastly, there are two jumpers ("sense switches") available on the board which may be read as two bits when a specific port is read. These jumpers are not used by Macrotech (or CompuPro for that matter) and are available for custom programming purposes.

**THE NUMERIC PROCESSOR**

Macrotech offers an optional 80287 numeric processor. The 80287 is similar in instruction set to the 8087, but differs in that it may run asynchronously with the main processor. Thus, while the 80286 runs at 6MHz, the 80287 was initially set up to run at 4MHz. Macrotech engineers concluded that the numeric processor will run reliably at 5.33MHz. Thus, they supply a simple patch to change the clock frequency. There have been no problems whatsoever in several months of operation.

The 80287 chip is an optional extra with a list price of $375. It is also possible to purchase the chip from another source at a lower cost, but Macrotech points out that selection of this option with the initial board purchase will include complete testing of that 80287 chip in place as well as a one year warranty. Rumor has it that some competitors have designed their CPU boards in such a manner that it is impossible for a user to field-install his own numeric processor, but Macrotech advises that their design allows the owner to simply plug and go. Consequently, those of us with the "hacker" spirit can roll their own 80287 installation at any time.
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- DISPLAY/MODIFY RAM - (MONITOR MODE) WITH 11 SUB COMMANDS
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INSTALLING THE BOARD

The MI-286 board was designed from the bottom-up specifically as a plug-and-go replacement for the CompuPro 8085/8088 CPU board. As such, great pains were taken to make the transition to the new board as simple as possible. Since the MI-286 is considerably faster than the older board, timing of the bus signals is a serious concern. Over months of beta testing by a small group followed by actual field experience with the real product, Macrotech engineers have compiled a detailed dossier of suitable solutions for problems encountered during the upgrade process. The manual provides detailed guidelines on the proper setting of wait states and other critical CompuPro board switch settings. There is also considerable information on hard disk controller boards of other manufacture, especially those offered by Gifford Engineering, as that firm has also taken part in beta testing of the MI-286, having adopted the CPU board as the primary offering in their S-100 systems. Hard disk controllers which are known to work satisfactorily, include the CompuPro Disk 2 and Disk 3 and the Konan DGC-100. There are definite problems with Morrow hard disk controllers. I would suggest that Macrotech be consulted before attempting to upgrade a system with a Morrow controller.

Both Macrotech’s and CompuPro’s static memories operate properly with the MI-286. All existing CompuPro I/O boards have been shown to operate correctly. If one intends to upgrade a non-standard system with the MI-286, I strongly recommend that the prospective purchaser contact Macrotech directly. It is my experience that the company is willing to work with system integrators to insure the best chance of success. In a worst case situation, the board might have to be returned (for full credit), but considering the substantial experience the troubleshooting engineers have gained over the past months, this is unlikely.

BENCHMARKS

In evaluating the CompuPro 8085/8088 and the Macrotech MI-286 processor boards, the bottom-line is found by comparing the execution of specific operations. Paul Homchick of Chimitt, Gilman, Homchick, Radnor, PA has done an exhaustive benchmarking and has graciously granted permission to present relevant details from his article. The full report is available directly from Macrotech or from Section DL9 of CP-MIG, the CP/M special interest group on Compuserve.

SIXTEEN BIT BENCHMARKS - First, a few simple machine instructions were executed 12,582,912 times. The running times (in seconds) are:

- 8MHz 6 MHz
- 8088 80286 ratio
- add ax,1 18.9 7.4 2.55
- mov ax,[30] 31.6 11.6 2.72
- short JMP 28.3 21.1 1.34

The two arithmetic instructions were executed 4,194,304 times:

- mul Word [30] 75.0 14.2 5.28
- mul Byte [30] 45.6 8.6 5.30

The Sieve of Eratosthenes is a very widely known and oft-used benchmark. Homchick coded it in Digital Research CB-86. Using either 8- or 16-bit wide RAM, the 8088 ran the program in 8.1 sec. The Macrotech 80286, using 16-bit wide memory and one wait state for memory reads only (a typical setup for a system using CompuPro memory) executed the same program in 3.6 sec. Thus the Macrotech MI-286 represents a 2.5-fold improvement in speed over the 8088.

EIGHT-BIT BENCHMARKS

I compiled a C language version of the sieve program with the Software Toolworks’ C80 compiler. CompuPro 8085 clocked in at 13 sec., while the Macrotech Z80H (using one MI wait state, a typical requirement for CompuPro memory) ran the benchmark at 10.8 sec. Note that an additional advantage over the MI-286 board would be realized with a compiler that produced optimized Z80, rather than 8085 (8080), code.

BENCHMARK SUMMARY

Homchick went into further detail in comparing the 80287 processor to a variety of other systems, as well as timing several “real-life” operations such as file copying, spreadsheet operation, etc. To summarize, the MI-286 out-performed the 8085/8088 yielding 2.5 and 1.2-fold decreases in the speed of 16- and 8-bit operations, respectively, during compute-bound applications. Application programs will vary widely of course, but it is reasonable to expect a minimum improvement in speed of 1.2 to 1.7-fold. Needless to say, the addition of the 80287 coupled with software designed to use it, will improve the speed of math-intensive applications up to two orders of magnitude.

CONCLUSION

As a devoted S-100 bus enthusiast, I have felt privileged to work with the MI-286, a truly state-of-the-art CPU board. Clearly, the S-100 bus has a promising future notwithstanding the tales of its demise so frequently reported in the trade press. Firms, such as Macrotech and CompuPro, are certainly in excellent technical health and I look forward to more advanced products from them in the months ahead.
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Description: Does global search of disk and retrieves all instances of searched word or phrase, in context, tells which file each came from and puts results in new file. Menu driven with 20 search options. User can set automatic defaults.
Price: $50 + $4 shipping. 30-day money-back guarantee.
Publisher: O'Neill Software
Box 26111
San Francisco CA 94126
(415) 398-2255

Program Name: DSD80 Symbolic Debugger
Requirements: CP/M-80 or equiv.
Description: Full screen symbolic debugger for 8080,8085 and Z80 code with display of instruction, registers, stack and two memory windows. DDT compatible. Includes commands for port I/O, string searching and defining symbols. Single keystroke commands for single stepping and scrolling. On-screen emulator and memory protection. Z80 instruction set fully supported using either extended Intel or Zilog mnemonics. Online help and 50-page user manual.
Price: $125 plus shipping
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Beginning of Line/End of Line
Scroll Up/Scroll Down
Window Up/Window Down
Scroll Left/Scroll Right
Top of File/Bottom of File

Block Commands
Copy/Move/Delete
Read/Write
Lower Case/Upper Case
Fill/Justify
Print

File Commands
Directory (with wild cards)
Show File/Help File
Input/Output File
Delete File/Save File

Other Commands
Split Screen/Other Window
Find String/Replace String
Replace Global/Query Replace
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Computer ____ Operating System: MSDOS ____ PCDOS ____ CPM80 ____
Name ____________
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Although the S-100 bus provides great flexibility and capability in the microcomputer world, there is also a place for more fixed designs. Single-board computers often represent a good combination of performance and cost that make them the preferred choice in many applications. One of these that I have been working with recently is the Slicer, from Slicer Computers & Controls.

THE HARDWARE

The basic system is on one printed circuit board a bit under 6" by 12". This contains a 80186 CPU, running at 8 Mhz, 256k bytes of memory, two serial ports capable of rates up to 38,400 baud, a floppy disk controller supporting both 8" and 5.25" drives, and a SASI compatible port that will interface to a hard disk controller such as the Xebec or Western Digital.

ROM circuitry supports up to 64k of code via 27256 chips, and a 8k byte monitor comes with the system (more on that later).

While this may seem to be quite a bit, the user needing more can add expansion boards. Along one edge of the main board are two headers carrying the data, address and control lines that might be needed. The boards are meant to be stacked with spacers, and the bus structure connects the boards via ribbon cable jumpers. While not as easy to reconfigure as a mother-board with edge connectors, this approach should be quite reliable, and allows future expansion without the initial investment in the large board used for interconnects.

The basic expansion board adds several capabilities to the system. It can add another 256k bytes of RAM, a parallel port for a printer, a real-time clock chip with battery backup, and 4 more serial ports, 2 of the same type as on the main board, and 2 that support both asynchronous and synchronous communication at rates to at least 1M bits per second. To enable these higher rates, interface is provided as TTL levels in addition to the standard RS-232 level conversion. For high speed burst transfer, a tie is provided between the Z8530 controller and the processor wait line so that string move instructions may be used. The clock chip has registers from seconds to years, with an internal 100 year calendar that handles leap years. It also has 50 extra byte size registers that are retained by the backup battery, where you can keep flags or data useful for system configuration or recovery from power failure.

Other expansion boards are now becoming available from slicer. One is a video display controller and keyboard interface, set up to match the structure of the IBM-PC. Also available is a prototype development board, a “forest of holes” with power bus and interface circuitry (address and data buffers, and high-order address decoding). This provides an “out” for those who need some non-standard interface or have an urge to tinker. I am presently awaiting these boards, with specific applications in mind for each.

THE MONITOR ROM

As I mentioned earlier, a monitor is supplied in ROM as a part of the main board. This provides support for all the hardware on this board, and a flexible set of debugger commands. Included with the standard dump, modify memory, examine register and such, are a set which can access any disk on the system, determine its type, and read or write multiple sectors. With the command processor having looping capability, it is easy to issue a command line to do a full disk to disk copy from the monitor. Also available are a set of commands to read and write all I/O ports for checking out hardware. One nice feature is a memory test section that needs no memory. By clever use of registers, the monitor can start up, communicate with the terminal, and execute the memory checkout with NO good RAM on the board. This makes it easy to isolate problems that might appear to be elsewhere, but are actually due to bad memory chips.

To support the technically inclined user for whom this system is intended, it is made available in several forms. Starting with a bare board (which includes special parts), kits progress through ones having the hard to get parts (easy kits), to full kits, lacking only solder and some of your time. Assembled and tested systems are also available for those not interested in building.

The expansion board is sold similarly, with the added flexibility of getting
one with components for a memory board, an I/O and clock board, or both for a full house.

SOFTWARE

Software to use the board is also available. Starting with CPM-86 ($85) as the "standard" system, MS-DOS ($175) is now available, with Concurrent DOS hoped for soon if licensing arrangements can be straightened out. The system can boot up from any drive, with the default being the A drive, but a monitor boot command allowing selection of any other. The system will auto-configure itself, recognizing what type of drive is at each position, and the density and format of the disk inserted. A SETUP program will interactively patch a data area of the boot routine placed on track 0 of the system disk, to customize other details of your system.

Such things as the CRT screen clear and cursor positioning commands are defined so that the monitor (and user programs that want to) can be terminal independent. Drive step rates are also set here, as are timeout delays for drive deselection and motor shutoff. The hard disk details such as number of heads, tracks, and capacity get defined, and the system partitions the available space into the needed number of logical drives. A memory disk may be defined for whatever amount of RAM you feel you can spare from program space. Two logical drives (E & F) are reserved to reference any two of the floppy drives, but with different format definitions, aiding file transfer between different type systems.

The way I got involved with the Slicer computer is a little tale with some interesting points itself. Last summer, a computefest known as SOG III took place the last weekend of July in Bend, Oregon. Sponsored by Micro-Cornucopia, a hobbyist magazine primarily for single board systems such as the Kaypro, Xerox 820, and the like, it fit in nicely with our vacation plans and provided an excuse to visit a part of the country I had never seen. Among the people there were the principal hardware and software designers of the Slicer. I had been reading about the various 16 bit system coming out, but hadn’t been happy with some of the technical compromises in the more popular “compatible” systems. Their presentation of the design choices made sense, and they made quite clear some of the hazier areas of this CPU type.

The next item was an invitation to build a system the next morning. The Slicer people had brought along several boards and bags of components, and ran a kit building session that Saturday morn-

ning on the front porch of the meeting hall.

Several brave souls turned up, and dug in. The experience ranged from several long time builders to some such as my wife, who could solder but didn’t really have much technical experience. In a period of about 4 hours, thirteen kits were assembled, and then checked one at a time in a system cabinet with power supply, terminal and disk drive. The initial checkout without RAM showed all 13 working the first time, a very good yield. After correcting one or two reversed memory chips, all systems passed with no more problem than a defective socket on one board.

The builders had the option of buying the board they had built at a show discount, and many took advantage of the offer, including yours truly. It was refreshing to get sensible answers to your questions, and the hands-on experience was an excellent way to judge the quality of design and material. One thing that surprised several people there who had not seen the new chips was the size of the CPU. Packaged in a 68 lead chip carrier, the processor is less than 1” square, looking quite small in relation to the 40 pin DIP packages used for the peripheral devices. It seems that as the capability goes up, the size goes the other way.

OPINION DEPARTMENT

This has been my first experience in the 16-bit micro system world, and I have been having great fun. I can’t comment on how many commercial software packages work because I just haven’t had occasion to try them. My interests being more along the line of system level software, the evenings have been spent with writing drivers, modern programs, poking around in the monitor and trying its many capabilities. Much of this was to develop a “feel” for the expanded instruction set of the CPU, and learn how best to manage the larger available memory. Some problems can be handled so much more easily when you aren’t cramped into a 64k memory.

One software package that I can mention positively is the Turbo Pascal system by Borland. I am not particularly a fan of Pascal, with the strict checking of the compiler discouraging some of the shortcuts that assembly language programmers resort to. This version, however, is very easy to work with, and has enough enhanced system calls to let you do what you need. One of the intended uses for the Slicer involved moving an existing program from a Z-80 system. Written in an older dialect of Basic, an extensive rewrite was needed, and Turbo was chosen for the project. Once the data file formats were converted, the rest went surprisingly easily.

The system still runs in an experimental configuration most of the time. At present it has two 8½” disks, two 5.25” drives (one each 48 tpi and 96 tpi), and a 34Mbyte formatted hard disk. It will definitely take a while to fill up all that space on the hard disk, but I am sure the old saw of “work expanding to fill the available space” will hold. The PC expansion board kit just arrived, so the program work will take a break while I warm up the soldering iron.

One area that still troubles me has nothing to do with the Slicer system, although working with it brought the problem into focus for me. This is the present “bandwagon” tendency shown by the numerous “compatibles” being pushed to the exclusion of possibly better systems. While standard systems make it easier for the software developer, I feel the neglect of more advanced systems can hurt the industry in the long run.

Both MS-DOS and CP/M have advantages and disadvantages with respect

<table>
<thead>
<tr>
<th></th>
<th>Prices</th>
<th>Full kit</th>
<th>Easy kit</th>
<th>Bare board</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Board Computer</td>
<td>$995</td>
<td>$795</td>
<td>$450</td>
<td>$150</td>
</tr>
<tr>
<td>Expansion Board</td>
<td>$750</td>
<td>$575</td>
<td>$95</td>
<td>$200</td>
</tr>
<tr>
<td>PC Expansion Board</td>
<td>$600</td>
<td>$350</td>
<td>$400</td>
<td>$200</td>
</tr>
<tr>
<td>Math Coprocessor Board</td>
<td>$300</td>
<td>$300</td>
<td>$300</td>
<td>$300</td>
</tr>
<tr>
<td>Hard Disk Controller</td>
<td>$200</td>
<td>$200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enclosure with Pwr Sply</td>
<td>$125</td>
<td>$125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enclosure with P.S.</td>
<td>$200</td>
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<td></td>
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<tr>
<td>2-floppies</td>
<td>$695</td>
<td>$695</td>
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<td></td>
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<tr>
<td>PC compatible keyboard</td>
<td>$150</td>
<td>$150</td>
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<tr>
<td>MS-DOS</td>
<td>$175</td>
<td>$175</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP/M-86</td>
<td>$85</td>
<td>$85</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bare board includes essential parts. Easy kit includes hard to find parts. Full kit includes all parts. A&T is completely assembled and tested.

Slicer Computers Inc. 2543 Marshall Street N.E. Minneapolis, MN 55418 (612)788-9481
Slicer
Continued from page 57
to each other, and at times it is hard to decide which way to go. Perhaps Concurrent DOS will at least partially help this problem.

SUMMING UP
In summary, I feel the Slicer is a good example of an integrated system. Although nominally a "single board" approach, the bus structure maintains expandability, although not quite as flexible as the mother board approach used in the S-100 systems.

It is certainly not a system for the novice or one looking for a "plug in and run" machine, but it can offer much to the technically oriented experimenter. If you want to try the slicer call the Slicer Bulletin Board System at (612)788-5909.

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The May '84 issue of Micro systems contained my review of Version 1.0 of C/nix, an outstanding set of programs that add many UNIX and MSDOS 2.1-like features to CP/M 2.2. Since the review was published, C/nix has continued to evolve and Version 1.56, now in distribution, introduces a sufficient number of new features to warrant an update to the review.

What's New

The numerous enhancements incorporated in Version 1.56 are:
- Root directory on each drive can now contain 31 subdirectories (versus 26 in Version 1.0).
- Version 1.0 input/output redirection operated only to and from files or the console. Now redirection works with files and following devices:
  - lst: listing device
  - con: console
  - pun: punch device
  - err: 'error' device, i.e. direct console output, bypassing BDOS
  - nul: bit bucket (output discarded)
- The CP/M STAT utility can be used to associate physical devices with the foregoing logical devices as desired.
- In Version 1.0, simple redirection to a file resulted in the creation of the target file. As a consequence, the target could not already exist. Now the form, > , will overwrite the target file if it exists.
- The cp and mv commands will now copy over an existing file of the same name. Inclusion of the -f switch will force the copy or move without confirmation.
- Adding the verbose switch, -v, will cause the names of the files copied or moved to be echoed to the console, a useful feature when cp or mv are used with wildcards.
- The directory command, ls, now has three new switches:
  - ls -f results in listing of files, but not subdirectories, in current directory.
  - ls -d results in listing of subdirectories only.
  - ls -t results in listing of total disk space used in current directory.
- A new command, walk [-b] command, has been added. Walk will display the pathname of the current directory and the pathnames of all of its subdirectories, followed by the pathnames of their subdirectories, etc. If walk includes 'command', then 'command' will be executed in each directory.
  - Thus, for example, 'walk rm *, bak' will erase all files with the extension, bak, in the current directory, in all of its subdirectories, in their subdirectories, etc., asking for confirmation before they are erased. As another example, how about getting a nicely organized listing of all the files on your hard disk?
    - This is easily done with 'walk ls -l'. This command will print the contents of the current directory, all of its subdirectories, their subdirectories, etc. If the -b switch is used following 'walk', it will cause walk to do a bottom-up rather than a top-down search.
    - Clearly, 'walk' is a VERY powerful command!
- Finally, the distribution disk now contains a new utility, set.com. Used with any or all of several switches, set.com has the following results:
  - set +p enables paging of help files on the console. The next page of a help file can be displayed by striking any key.
  - set +v turns on the verbose mode for cp, mv, and rm as well as for command files.
  - set +b will cause the console bell to sound at the end of each page of a help file.
  - set +c forces confirmation before proceeding with cp, mv, or rm.
- The use of - rather than + with a switch will turn the corresponding function off rather than on.

Worthy of Note

Although not new with Version 1.56, it is worth noting that the help facility works with any files that have the extension 'hlp'. As a result, you can use the help facility to access text of your own choosing simply by putting it in an ASCII file with that extension. You can then display your file by typing 'help filename'. For example, if you have limited disk space, instead of using the supplied help files (which are about 100K in size) you may want to create a new help file similar to Table 1 which contains just a command summary. Note that help files must reside on the disk from which C/nix is loaded. They can be invoked, however, from any directory on any disk. Finally, I must mention that the distribution disk also contains grep.pre. Although a slightly different syntax is used, grep is a full implementation of the marvelously useful UNIX generalized regular expression parser. Once you have used it, you will wonder how you managed without it. It is almost worth the price of the C/nix package by itself.

File Sizes

The addition of the enhancements described above has resulted in a modest increase in the size of the C/nix files as shown below:

<table>
<thead>
<tr>
<th>File</th>
<th>Old Size</th>
<th>New Size</th>
</tr>
</thead>
<tbody>
<tr>
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<td>25.4K</td>
</tr>
<tr>
<td>CNIX.COM</td>
<td>28.5K</td>
<td>28.5K</td>
</tr>
<tr>
<td>CNIXHIGH.SYS</td>
<td>1.5K</td>
<td>1.9K</td>
</tr>
<tr>
<td>CNIXUTIL.PRE</td>
<td>10.8K</td>
<td>11.0K</td>
</tr>
<tr>
<td>SET.COM</td>
<td>N/A</td>
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</tr>
<tr>
<td>GREP.PRE</td>
<td>10.4k</td>
<td>10.4k</td>
</tr>
<tr>
<td>CNIXHIGH.SYS</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

CNIXHIGH.SYS is the only one of these files that must be RAM resident, so Version 1.56 requires you to give up an additional 0.4K of TPA space, a modest sacrifice for the additional capability provided.

The Manual

The C/nix manual has been upgraded in several respects. It now contains substantially more explanatory material and has expanded to 58 pages from 41 in the earlier manual. In addi-

(continued on page 61)
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The enhancements eliminate most of the shortcomings of Version 1.0 so that C/nix now provides a powerful set of utilities for the CP/M user, although it will still be of most interest to those who have lots of disk space. If you have a hard disk, I think C/nix is an essential addition to CP/M. I strongly recommend it.

**C/nix Distribution**

The distribution of C/nix is now handled by The Software Toolworks, a well respected software publisher. Their address is:
The Software Toolworks
15233 Ventura Boulevard,
Suite 1118
Sherman Oaks, California, USA
Phone (818) 986 4885

### Price

The price of C/nix has been reduced to $59.95 (US dollars). Shipping costs $2.00 for 5 1/4 inch disks and $3.00 for 8 inch. Outside the United States, shipping costs $5.00 (US Dollars).

---

**TABLE 1**

<table>
<thead>
<tr>
<th>commands (cmd)</th>
<th>Summary of C/NIX Commands</th>
</tr>
</thead>
<tbody>
<tr>
<td>bye</td>
<td>leave the C/NIX shell (exit)</td>
</tr>
<tr>
<td>cat file1 file2 ... &gt; outfile</td>
<td>concatenate text files</td>
</tr>
<tr>
<td>chdir</td>
<td>output text in parent directory</td>
</tr>
<tr>
<td>chmod</td>
<td>change to a new directory</td>
</tr>
<tr>
<td>cp file1 from file2</td>
<td>change &quot;mode&quot; of files</td>
</tr>
<tr>
<td>cp [-f] [-v] file1 ...</td>
<td>-- synonym for chdir</td>
</tr>
<tr>
<td>cpio</td>
<td>copy a file</td>
</tr>
<tr>
<td>cpio [-f] [-v] file1 ...</td>
<td>copy files to new directory</td>
</tr>
<tr>
<td>cpio [-v] file1 ...</td>
<td>invoke sub-shell on command file</td>
</tr>
<tr>
<td>dir [-ldt]</td>
<td>list directories (ls)</td>
</tr>
<tr>
<td>dir [-ldt] pattern1 pat2 ...</td>
<td>list current directory (ls)</td>
</tr>
<tr>
<td>echo param1 param2 ...</td>
<td>echo parameters to console (csh)</td>
</tr>
<tr>
<td>eras [-f] file1 ...</td>
<td>erase files (rm)</td>
</tr>
<tr>
<td>exit</td>
<td>exit the C/NIX shell</td>
</tr>
<tr>
<td>grep &quot;pattern&quot; file1 ...</td>
<td>search files for a pattern</td>
</tr>
<tr>
<td>gc</td>
<td>search console input for a pattern</td>
</tr>
<tr>
<td>help topic1 topic2 ...</td>
<td>display help information</td>
</tr>
<tr>
<td>help [-ldt] pattern1 pat2 ...</td>
<td>display list of help topics</td>
</tr>
<tr>
<td>la [-ldt]</td>
<td>list directories</td>
</tr>
<tr>
<td>la [-ldt]</td>
<td>list current directory (la)</td>
</tr>
<tr>
<td>man topic1 topic2 ...</td>
<td>display pages from manual (man)</td>
</tr>
<tr>
<td>man</td>
<td>display list of manual pages (man)</td>
</tr>
<tr>
<td>mdir dir1 dir2 ...</td>
<td>make directories</td>
</tr>
<tr>
<td>mkrel file00 file200 file.pre</td>
<td>make page-relocatable program</td>
</tr>
<tr>
<td>mv [-f] [-v] oldname newname</td>
<td>move/rename a file</td>
</tr>
<tr>
<td>mv [-f] [-v] [-i] file1 ...</td>
<td>move files to new directory</td>
</tr>
<tr>
<td>pwd</td>
<td>print pathname of working directory (chdir)</td>
</tr>
<tr>
<td>ren oldname newname</td>
<td>rename a file (mv)</td>
</tr>
<tr>
<td>ren oldname=newname</td>
<td>rename a file (mv)</td>
</tr>
<tr>
<td>rm [-f] file1 ...</td>
<td>remove files</td>
</tr>
<tr>
<td>rmdir dir1 ...</td>
<td>remove directories (rmmdir)</td>
</tr>
<tr>
<td>set [+] [var0] ...</td>
<td>set certain user interface parameters</td>
</tr>
<tr>
<td>submit cpiofile param1 ...</td>
<td>submit command file (can)</td>
</tr>
<tr>
<td>type file1 ...</td>
<td>type text files (cat)</td>
</tr>
<tr>
<td>walk [-b]</td>
<td>walk directory tree</td>
</tr>
<tr>
<td>walk [-b] command param1 ...</td>
<td>walk and execute command</td>
</tr>
</tbody>
</table>

**NOTES**

Optional flags are given in brackets, with alternatives separated with vertical bars. Ellipses (...) are used to represent a list of files, etc. All of the above are recognized within the shell, except for grep and mkrel. All but these two and chmod, mdir, and cpio are also implemented entirely within the shell. The commands chmod, mdir, and cpio are implemented by chinux.util.pre.
Program Interfacing To MS-DOS

by William G. Wong

The second part in this series of articles explores some specific character device input and output functions. Character devices include the keyboard, display console, auxiliary devices (usually a serial port), and the printer. The character functions can deal with a single character or a string of characters.

The character devices can also be accessed as files using file names such as CON:. Use of these filenames and file input and output functions will be described in a later article which will also cover disk-file support, since the functions are the same.

The functions described in the rest of this section are essentially identical to the analogous CP/M functions. However, there are a number of nice improvements. The following table provides a quick overview of the functions available.

### Character Input and Output Support Functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Parameters/results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Keyboard input</td>
<td>AL char</td>
</tr>
<tr>
<td>2 Console output</td>
<td>DL char</td>
</tr>
<tr>
<td>3 Auxiliary input</td>
<td>AL char</td>
</tr>
<tr>
<td>4 Auxiliary output</td>
<td>DL char</td>
</tr>
<tr>
<td>5 Printer output</td>
<td>DL char</td>
</tr>
<tr>
<td>6 Direct console I/O</td>
<td>AL char or FF hex, AL char/status</td>
</tr>
<tr>
<td>7 Direct console input w/o echo</td>
<td>AL char</td>
</tr>
<tr>
<td>8 Console input w/o echo</td>
<td>AL char</td>
</tr>
<tr>
<td>9 Print string on console string ends with '$'</td>
<td>DS:DX string address</td>
</tr>
<tr>
<td>A Buffered keyboard input</td>
<td>DS:DX buffer address size, entered, string</td>
</tr>
<tr>
<td>B Check console status</td>
<td>AL (0 not ready, FF ready)</td>
</tr>
<tr>
<td>C Clear input buffer and do function</td>
<td>AL function code (1, 6, 7, 8, A)</td>
</tr>
</tbody>
</table>

The function number is passed in the AH register. Output functions use the DL or DS:DX registers for parameters and input functions return the results in the AL register.

### Part II — Dealing with character input and output functions.

#### OUTPUT FUNCTIONS

The output functions have two forms for the console and one for the printer and auxiliary port. The following example shows the console output functions.

```assembly
MOV AH,2 ; AH : console output
MOV DL,'A'; DL : display charac
INT 21H ; call DOS & output char
```

There are some restrictions on use of these functions. The first is that normal console output (function 2) recognizes the control-S and the control-BREAK (or control-C on some systems) input from the keyboard. The control-S causes the program to wait for a subsequent control-Q from the keyboard. This is useful because many terminals allow a user to stop and restart a program while it is running. The control-BREAK function can be executed, while the default function aborts the program. Note, the control-BREAK function can be redefined as any function to be supplied by the program as described in my previous article.

The control-S and control-BREAK options will not be checked if the direct console output function (function 6) is used. Instead, it is then up to the program to poll the console to see if any of the various control key options have been entered. This is the normal method of retaining program control during output without replacing the control-BREAK function. There is one restriction in using this method of output. That is the character FF hex cannot be sent to the console because this value indicates that a console input function is to be performed. This restriction is usually not a problem.

The print-string function is very useful since it allows a number of characters to be displayed at one time, without having to resort to single-character output functions. The function is actually a remnant of CP/M because the string terminator is the dollar sign ('$', 24 decimal). The unfortunate result is that you cannot print a string which contains a dollar sign. Also, this function has the same restrictions as console output function 2.

The following is an alternative to function 9 in that the string terminator is a FF hex and it uses function 6 to output each character. Note, FF hex was chosen as the string terminator because it cannot be output using function 6. It also allows a NUL character (0 hex) to be in the output string. This is useful because many function-key programming options on terminals often use the NUL character as a function-key string terminator.

### A similar function can be created for auxiliary and printer output functions (Functions 4 and 5, respectively) perform just like function 2, except that keyboard input is not
examined. One useful function to create is a printer-output function which checks the console after each character is printed, to see if the user wants to stop or pause a printout.

**INPUT FUNCTIONS**

Character input is available from the keyboard and the auxiliary device, but not from the printer. There are a number of keyboard-input functions, but only one auxiliary-input function. This really limits the latter.

The auxiliary-input function gets a single character from the serial port. It waits until a character is available and there is no associated-status function extant. For this reason, the function is not normally used for communication programs which access the serial port. The following is an example of the auxiliary input function:

```assembly
MOV AH,3 ; AH := aux input func.
INT 21H ; AL := aux input char.
```

Luckily, the keyboard-input functions are more varied and flexible. Keyboard-status functions are available, in addition to keyboard-input functions. The normal single character-input functions is number 1. When selected, the system waits until a single character is available from the keyboard, before returning to the calling program. The following is an example of this basic-keyboard input function:

```assembly
MOV AH,1 ; AH := keybd input func.
INT 21H ; AL := keybd character
```

The character entered is also echoed on the console. Entry of a control-BREAK key sequence causes the control-BREAK function to be invoked. On some systems, such as the IBM-PC, a function key often generates characters at once. The first is a 0-hex, followed by a second character requiring two input-function invocations to produce two characters.

Unfortunately, this basic keyboard-input function is not sufficient for most sophisticated programs, because control-BREAK will normally be processed by the program. Also characters entered may not always be echoed on the console. Some of the following functions provide this support.

Function 8 provides the same type operation as function 1, except that the character is not echoed. It still recognizes the control-BREAK key. Function 7 is the same as function 8, except that it does not recognize the control-BREAK at the DOS level. Instead, the character is returned as a result of the function invocation in the AL register, thereby allowing the program to process the key sequence.

In the last three cases, DOS waits for a key to be pressed before returning to the program. A program can check the keyboard status before using any of these functions. This would allow the program to continue to perform useful work, such as copying a file while polling the keyboard. The following example shows how the keyboard status is obtained.

```assembly
MOV AH,0BH ; AH := keybd status func.
INT 21H ; AL := (O-no char. available, ; OFF if no character)
```

The only drawback to using this function is that the control-BREAK will cause the control-BREAK function to be invoked.

The control-BREAK check can be bypassed by using the direct-console I/O function (function 6) with OFF-hex as a parameter in the DL register. The function always immediately returns the value of the key entered or a zero indicating that no character is available. The control-BREAK is returned as with any other key.

The last-single character input function is the clear-input buffer and read-next-character function. This is function 0C-hex requiring a sub-function code in the AL registers. This must be a 1, 6, 7, 8 or 0A hex, which are keyboard input or status functions. The input buffer must be cleared of any characters before the sub-function is invoked. This alleviates the need for an internally-coded function in a program which would read everything in the input buffer before invoking the sub-function.

Finally, there is the buffered keyboard input function. This function requires a buffer address as its parameter. It allows the user to enter a line of text, which is terminated by the return key. Each character will be echoed on the screen and basic edit capabilities can also be used.

The buffer contains two prefix bytes located before the actual buffer address. The first contains the size of the buffer in bytes and the second the number of characters entered, not including the return key. Filling up the buffer does not cause the function to complete as on some CP/M systems. The following is an example using the buffered input.
Buffered input is an easy way to provide a standard input method to the user. The alternative is to write another procedure which does the same thing, plus giving the programmer more control over the characters entered and the function keys.

**SUMMARY**

MS-DOS provides a good set of character I/O functions for the keyboard and console, but is lacking, when with respect to the printer and auxiliary ports. Adding input and output status calls would have made the system more flexible.

The next installment in this series will cover diskfile support, including namedfile support for the console and printer.

*Bill Wong is the President of Logic Fusion, Inc., a systems software development firm located in Yardley, PA.*
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Concurrent PC-DOS

by Michael Guttman and Vincent Mills

Editor’s Note: Concurrent DOS, is available for some 8086/186/286-based S-100, and other systems, supporting up to 16 users. It is essentially the same as Concurrent PC-DOS with the exception that it lacks MS-DOS compatibility.

Concurrent PC-DOS (C/PC-DOS) is the latest in a series of multitasking, multiuser operating systems from Digital Research Incorporated (DRI) of Pacific Grove, California. Designed to run on a IBM-PC or compatible (either alone or with up to two terminals), C/PC-DOS features support for applications developed under either PC-DOS and C/PM-86.

Under C/PC-DOS, up to four applications can run simultaneously on a stand-alone PC, each appearing in its own ‘window’ on the screen. These windows can sized, placed and ‘tiled’ over one another as the user desires, allowing a full or partial view of every background and foreground activity.

As a windowing environment, C/PC-DOS is entering what promises to be a crowded field, a field that may soon be dominated by IBM’s Topview and various Topview clones already nearing release. However, C/PC-DOS does offer an opportunity for those most familiar with CP/M and its variants to migrate to the IBM-PC environment with a minimum of hassle, allowing them to mix their applications with the more ubiquitous PC-DOS productivity software such as Lotus 1-2-3, Symphony, Framework, etc.

In addition, C/PC-DOS is the only windowing environment currently offering multiuser capabilities. Up to three users can work simultaneously, with one user multi-tasking from the IBM-PC screen and keyboard, while two other users are at work at standard terminals connected to serial RS-232 ports at up to 9600 baud.

For a mere $295, C/PC-DOS offers all this as well as a smorgasbord of system utilities and bundled software. It definitely seemed worth a gander.

A review of DRI's new 16-bit multiprocessing multi-user operating system.

GETTING STARTED

C/PC-DOS arrived in a brown binder box containing a thick manual and five distribution diskettes. According to the instructions, C/PC-DOS requires a minimum of 256K and two floppy disks. However, this would be a pretty sparse configuration, and DRI recommends at least 512K and a hard disk drive. We certainly can’t imagine trying to run four applications concurrently from a floppy-only system.

As far as the hard disk is concerned, C/PC-DOS can be installed on either the root directory of DOS or on a separate CP/M-86 partition of its own. If a hard disk already has data and is partitioned to PC-DOS only, the DOS option is simplest. We tried both and rather liked the CP/M-86 option; it created two partitions, one in DOS format, the other in CP/M format.

In our case, these functioned respectively as drives C: and D:. Interestingly, media of either type would copy to one another, from or to hard disk or floppy, and programs from either operating system would run on either partition. We did notice that program loading seemed faster from the CP/M partition.

DRI has made installing C/PC-DOS a breeze. A batch file invoked upon boot-up automatically copies all the distribution to the hard drive, prompting the user appropriately at every step. The installation also creates an appropriate ‘autoexec.bat’ file for boot-up loading of C/PC-DOS.

GETTING FAMILIAR

Once loaded, C/PC-DOS doesn’t appear very different from PC-DOS. A familiar C> prompt appears, and most PC-DOS commands work as expected. At this point, the only obvious difference is the appearance of a C/PC-DOS status line on the 25th video row. Multitasking is already in progress, however, and some performance degradation versus PC-DOS will already be apparent (we figured about 10-15%).

C/PC-DOS really starts cooking’ when the user enters the control key sequences that activate windowing. Using a CTRL-1, CTRL-2, CTRL-3, and CTRL-4, the user can round-robin among the four available tasks, starting and stopping programs in each at will. Of course, as tasks mount up, degradation rises, particularly if these tasks are simultaneously updating the screen or writing to disk.

Invoking the WMENU window manager from any window adds some spice to C/PC-DOS. After loading WMENU, typing a CTRL-t activates this memory-resident program, allowing the user to easily change the window positions, sizes, colors, etc. even while other programs are executing. WMENU generates another window with easy-to-understand prompts on the 25th video line, temporarily replacing the C/PC-DOS status line. It is possible to create some very artistic collections of windows, manipulating the screen colors in each window to heighten the effect. When the user is done manipulating his windows, WMENU politely disappears into the background and the main status line reappears.

However, there are some severe limits to what can be effectively placed on the screen. C/PC-DOS itself takes up some 150K, and each active process will require at least 64K and usually 128K or more. Before you know it, even a fully loaded 640K system will...
Fin all y, pro gram s that use files by date and storage volume on the display. Volume identifier that makes keep the current cursor line in the backup is labelled with a unique potential a rather frustrating experience.

In addition, not all programs are well-behaved enough to co-exist in the windowing environment. Our version of Wordstar 3.3, for example, wrote all over the screen without any respect for window boundaries. NewWord, the Wordstar clone, worked better, keeping within its window boundary, but its cursor and text would disappear behind other windows, despite a ‘tracking’ feature that is supposed to keep the current cursor line in the display.

Other programs, such as Sidekick or Prokey, simply collide with C/PC-DOS, particularly if they are designed to remain memory resident. Finally, programs that use copy-protection schemes not compatible with C/PC-DOS will also not run properly.

We find it hard to look at these as problems with C/PC-DOS itself. The real problem lies with the fact that not all software is ‘well-behaved’ enough to exist in any off-the-shelf windowing environment. This is because many programs need to bypass standard DOS calls to achieve acceptable performance, particularly in the area of video I/O (see sidebar). In addition, it seems painfully clear that the IBM-PC’s hardware is just not powerful enough to effectively support the kind of multitasking theoretically possible under environments like C/PC-DOS.

C/PC-DOS does have some compatibility problems with PC-DOS for which there seems to be no good excuse. Some of the problems have to do with the fact that C/PC-DOS was originally designed to match DOS 1.1, leaving out the 2.x level system calls that many programs and particularly many hardware drivers have come to depend on. A new version, C/PC-DOS 4.1, due shortly, is supposed to solve these system call problems. (Editor’s Note: we hope, shortly, to publish a review of C/PC-DOS 4.1 running on an S-100 system.)

DRI did make C/PC-DOS work with 2.x directory structures, supporting hard disk, subdirectories and the 360K floppy format. However, DRI fudged in other areas, such as leaving out the very useful PATH command. The function of PATH has, however, been partially replaced by a SYSDISK command that sets a single global system directory and supplemented by a scheme of ‘floating’ logical disk drives N and O that can be reassigned to other drives and sub-directories.

DRI also left out the popular advanced batch file commands, such as IF, FOR, and GOTO, crippling us invertebrate users of sophisticated batch files. Another annoying change is the removal of the editing functions normally assigned by DOS to function keys F1 through F5, particularly key F3, which is used to repeat the last DOS command given. DRI has replaced these with a function key assignment system that is user-definable but not compatible with PC-DOS.

**THE BACKREST UTILITY**

C/PC-DOS supports so many utilities and programs, it is impossible to review all of them in depth. However, here is a detailed look at one very good example of a DRI utility, the BACKREST program.

BACKREST consists of the files BACK.CMD, REST.CMD and COMMAND.BR. BACK and REST make backing up and restoring hard disk partitions a pleasure. When backing up, these programs copy or restore only files changed or created since the last backup. The user is prompted to insert the diskettes in the correct order. Each disk used for backup is labelled with a unique volume identifier that makes restoration a breeze.

BACK keeps track of where things can be found in a special file called DIR.BR, which contains a record of all files by date and storage volume on the hard disk. This file is saved at each BACK session automatically.

True hackers will appreciate the customized command file, COMMAND.BR. Using this file, you can specify what defaults the utilities should use in execution, such as whether to reuse disks in your backup set and what colors you prefer for your color monitor. Unfortunately, only hackers will use it. Reading the 88K of directions for customizing the command file took one night by itself (and they are on the distribution disk, and not in the User’s Guide where they belong.) Some of the commands, like ERASE and REUSE, we think are especially prone to be misunderstood and therefore be used destructively.

CP/M file password structures (for CP/M media only) are maintained automatically, provided the command file contains exception records for this purpose. However, the files (and the backed-up copy of COMMAND.BR) are NOT protected on the backup disks. This implies anyone with access to a backup set could conceivably breach the password feature.

More than one drive can be specified in the source set; CP/M and DOS partitions are handled separately and require respectively formatted media.

Each backup disk generated by BACKREST contains a volume number as a directory entry with a zero length. The files are stored literally as they were on the hard disk, making emergency restoring easy. This is quite a change from PC-DOS which added a header to each file, making them impossible to restore without RESTORE. Prior to DOS 3.00, RESTORE couldn’t restore to floppies, which meant that if your hard disk should quit you wouldn’t be able to restore your files to temporary floppies.

Unfortunately, any advantages of BACKREST over PC-DOS BACKUP and RESTORE are overridden by a very drastic reduction in throughput. Here are some representative test results running BackRest.

<table>
<thead>
<tr>
<th>Time for</th>
<th>Number of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saving 338 files</td>
<td>disks used</td>
</tr>
<tr>
<td>With BackRest: 2 hours, 9 minutes</td>
<td>16 disks</td>
</tr>
<tr>
<td>With PC-DOS: 36 minutes</td>
<td>14 disks</td>
</tr>
</tbody>
</table>

* Used the default VERIFY type of backup. Non-VERIFY is not recommended.

In our opinion, there is no excuse for the slow execution time of BACKREST. Most users will probably lose track of what they’re doing before the backup is finished.

C/PC-DOS is its multiuser capabilities. For the price of two terminals and connecting cables, C/PC-DOS users can add two workstations to their PC. A few other products (Software Link’s Multilink, for example) offer similar capabilities, but not with all the other functions offered by C/PC-DOS.

Activating the extra users first involves using the SETPORT command to set the appropriate serial ports to the hardware characteristics of the attached terminals. Then, using the SETUP program, the user enables the ports as separate consoles. The configuration thus created can be saved using the Save System Parameters function in the SETUP.

Getting the terminals operational
was a piece of cake. A null modem to an Apple IIc running terminal emulator worked just fine. If problems do occur, they can be alleviated by turning off some of the handshaking options using SETPORT.

The slave consoles are subject to some restrictions not applicable to the PC console. No multitasking or windowing is allowed, no C/PC-DOS status line appears, and IBM-PC function keys are not operational. Unfortunately, this effectively disables any software for which function key input is mandatory.

In addition, the restrictions on video are even more severe; only ANSI video display calls will work. Since the terminals are also restricted to a 9600 baud serial transfer rate, serious speed degradation occurs with programs doing extensive video updating.

Obviously, these terminals would only be useful running very vanilla-flavored programs (Multiplan, SuperCalc, DbaseII). Furthermore, these programs would have to run within the restrictions of available memory, and would therefore further limit the multitasking activities of the main PC console.

These restrictions severely limit the real usefulness of the multiuser features of C/PC-DOS. Only small tasks with limited console I/O would really be appropriate. Once again, the problem seems to be not so much with C/PC-DOS, but with the underpowered hardware of the IBM-PC.

Another weakness that affects C/PC-DOS multiuser operation is the absence of file password protection. Once again, this is more attributable to PC-DOS than C/PC-DOS, since the DOS file and directory structure does not provide space for password flags. Using C/PM-86 media, however, password protection is preserved.

**The Operating System and its Utilities**

The C/PC-DOS operating system is invoked with LOADCCPM.COM, which loads CCPM.SYS, the resident module that handles user requests, task scheduling, and system input and output. It can emulate much of the PC-DOS commands as well as certain C/PM-86 commands. Upon loading, CCPM.SYS scans the file CONFIG.SYS, looking for FIXED-DEVICE commands that designate installable device drivers. CCPM.SYS recognizes only CONFIG.SYS commands in the form FIXED-DEVICE = filename.ext.

As mentioned earlier, the operating system is supported by two configuration programs, SETPORT and SETUP. SETPORT configures the serial ports for console and communications use. You can set the RS-232 parameters and handshaking to match any device from 110 to 9600 baud.

**DRI's C/PCDOS Programmer's Pak**

These rich and wonderful volumes include the following:

- RASM-86 Relocatable Assembler - a full-featured assembler, with support for the 8087 coprocessor built-in. Mnemonics are Intel standard with a few variations. This assembler seems much easier to use than IBM's own assembler.

- LIB-86 Object Librarian - keeps track of object, map and cross-reference files in a library format accessible to the linker. In any large programming task, it is useful to have a way to organize object and other compiler-generated files in a single consolidated scheme. It also cuts down on the number of files the linker has to keep open when running. This tool is not included with IBM's assembler.

- LINK-86 Object Linker - makes .CMD files for C/PC-DOS. It can also handle overlays, which require a little trickier programming but result in smaller memory requirements. Of course, memory consumption is a crucial point with multi-tasking systems. .CMD files are the combination of one or more .OBJ files. .CMD files can be no greater than 64K (just like .COM files).

- XREF-86 Cross Reference Generator

- SID-86 Symbolic debugger - just pass it the names of the .CMD and .SYM (symbol table) files and away you go. Everything is here. Symbolic table(s) aid greatly in the debugging process. It's almost like watching the source code running. Could be improved greatly if issued as a screen-formatted system.

- Sample Programs - DRI includes some useful sample programs such as:

  1. Window source code - WMENU, written in C and assembler, is a great example of how to do windows. High-level routines in C call several small assembler routines that do all the muscle-work in altering the characteristics of the four windows. Since WMENU uses a keyboard interrupt (Ctrl-Grey+) to become visible, it shows how to write memory-resident desk accessory software. The Digital Research C/TV compiler is required to compile the programs with extension .C (not included).

  2. Queue communications examples - PROTOCOL.A86 and SAMPLE.A86. Queue Driven Serial Communications refer to the buffering of communications data between an outside source and your computer. In a multitasking environment, communications data (say, from your modem) can pile up faster than your computer can handle. TERM.A86 shows how to use the operating system to do this buffering for you.

- PROTOCOL.A86 - program to set interrupt protocol for serial ports SAMPLE.A86 - program shows how to use the XIOS backdoor entry points that allow you to write directly to the virtual console buffer and still work in C/PC-DOS's windows. Although it is a bit complex, the fast speed makes it worthwhile if you're programming for windows.

- TERM.A86 - dumb terminal program which uses the Queue Driven Serial Communications capabilities of C/PC-DOS.

- SYSTAT - dynamically shows the status of system queues, memory and process status. You can select the rate of update, and run this in the background of any program.

- GSX-86 User's Guide and Programmer's Guide - GSX is the Graphics Extension to C/PC-DOS, the precursor to GEM, their Graphics Environment Manager. It allows you to address a graphics input or output device in a nonspecific way, a way compatible with many other device drivers. Unfortunately, no device drivers are included with either C/PC-DOS or in the Programmers Pak. Without these device drivers, you can't use the GSX software.

- Concurrent PC-DOS - goes in-depth into the inner workings of C/PC-DOS and lists the operating system calls available to the programmer. Though these calls are not compatible with PC-DOS itself, they provide access to the guts of the operating system and the communication queues. Programs that operate as separate, concurrent processes can pass data to each other using queues. Any process can create queues or spawn other processes.
at least 256K of memory, only memory in excess of 256K can be used as a memory disk. MDISK provides up to 256K of RAM disk. The user can change both the size and the starting address of MDISK.

Diskette head step time — You can improve your diskette performance sometimes by adjusting how fast the head moves across the diskette surface. The default value is fine for starters.

Verify after diskette write — Enabling write verification results in greater data security at the expense of processing time. After each write to a floppy diskette, a read checks to be sure the write worked. This feature was put in by IBM as "insurance," in case their original CDC floppy drives were to act erratically once the machine was in the field. Luckily, the drives turned out to work fine without verification. (Interestingly, the two DOS Interrupt 21H calls that change the verify flag in PC-DOS are not supported by C/PC-DOS!)

Maximum memory per process—You may set a limit on the amount of memory available to each .CMD program, normally the full available amount. This can become a problem if you start a very large CP/M program and want to change windows in-process.

Color monitor scroll mode — Use this menu selection to select the display update rate, from wide open (flickering) to slow and sure.

Updating CCPM.SYS and rebooting — After any changes have been made, SETUP updates the copy of CCPM.SYS on the system disk. Note that none of the changes made appear until the system is rebooted.

HDMaint is a menu-driven command that performs hard disk maintenance tasks. Although the main purpose of HDMaint is to format your hard disk before initial usage, you can also use it to change the partitioning on a blank disk or the volume name.

DSKMAINT is C/PC-DOS's version of DSKCOPY, FORMAT and DISKCOMP, combined into one menu-driven program. DSKMAINT can copy, format or verify either DOS or CP/M floppies.

BACKREST is a disk backup and restore utility written by Stok Software, Inc. and licensed for distribution by DR. It uses a customized control file to direct the backup process in an automatic and painless fashion (see sidebar).

WMENU and WINDOW — as discussed earlier, WMENU is a memory resident program that allows you to easily change the window formats from the keyboard while perserving the operation of ali concurrent tasks. WINDOW is a batch version of WMENU that allows the user to set up window attributes in advance via a system batch file.

BATCH Commands — like PC-DOS, C/PC-DOS can invoke a series of commands from a batch file. Unlike PC-DOS, Concurrent has a BATCH.CMD file that controls batch processing when needed, by line by line. Having an external batch processor (necessary because of the hybrid nature of C/PC-DOS) makes command files rather slow. They seem to virtually crawl across the screen, with 4 seconds or more between prompts.

CHDIR and MKDIR — familiar subdirectory commands cloned from PC-DOS. For some reason, these work with multi-level subdirectory commands such as CHDIR \ralph\wss\txt, while other commands such as DIR will support only one level of subdirectory referencing.

TIME and DATE — These CMD files allow you to change the on-screen time and date, two functions normally handled internally by COMMAND.COM. I've found that the ASTCLOCK command that comes with AST boards for the PC sets the time and date for the system satisfactorily.

TYPE — You can display the contents of a file on the screen, as well as on the printer. In C/PC-DOS, the COPY command used to start the test was: MASM program;<cr> For the one job test of C/PC-DOS, the same command as the PC-DOS test was entered from the window 1 with no other windows or consoles active - the best possible conditions.

For the two job test of C/PC-DOS, one compile was run from the console in the first window with no other windows active, and the second compile was submitted from an Apple //c running in terminal mode at 9600 baud.

RAM DISK TESTS

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The results of these tests are tabulated below. The results seem to indicate that:
1) the overhead of concurrency slows down a single job in the order of 15-20%.
2) the addition of a second job did not seem to affect total throughput on the system very much; running two identical jobs concurrently took just about twice as long as one alone.

Figure 1: Hard-disk test of Compile

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Performance Testing

We ran some performance tests to find out just how much degradation occurs when we take advantage of C/PC-DOS's concurrency. As a task-disk- and computation-intensive task, we compiled two separate programs in PC-DOS and one and two process C/PC-DOS jobs.

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Program 3:2:32

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WHAT WORKS, WHAT DOESN'T
A PC-DOS compatible program list

We tested a grabbag variety of programs we had lying around, and also included some of the programs listed in the User's Guide Supplement. Programs marked "works" we tested; "certified" programs are DRI tested.

Programmer tools (all work)

PROLOG TED, a programmer's editor

MAKE Microsmiths tools
download (downloader systems)
2500 A.D. cross-assembly
ASMGEN disassembler
Modula-2 from Modula Research Institute

TURBO Pascal from Borland
International

Communications programs
PC-DIAL works
New plans - written in

TURBO Pascal

Graphics Processors

DR Draw certified
DR Graph certified
PFS:Graph certified

Accounting programs

General Ledger certified
Home Accountant certified

Word processing programs

Word processing is a tricky subject. Although you can only process a word so many ways, many programs on the market use clever ways to update the screen faster. Programs don't follow the rules for displaying a character because the IBM-supplied routines are just too slow.

PC-WRITE doesn't works - crashes system

Microsoft WORD freezes up just before starting up
Wordproof from IBM works
WordStar works certified (but 3.3 ignores windows)
NewWord (WS clone) works

MultiMate certified
PFS:Write certified

ThinkTank doesn't work - bombs out on copy protection

Database programs

PFS:File works certified
PFS:Report certified

dBASE II works certified

Freeware works

Spreadsheet programs

Spreadsheet programs are basically character-oriented and have very simple I/O tasks; therefore most all tested programs designed for DOS 1.00 or 2.x seem to work correctly. Large spreadsheets usually indicate large memory requirements, which might be a problem to a prospective business user.

Lotus 1-2-3 works certified
Multiplan works certified
SuperCalc 2 certified
SuperCalc 3 certified
VisiCalc certified

Utility programs

These utility programs were kicked out for differing reasons:

PC Mouse didn't work because Terminate and Stay Resident programs usually change some interrupt vectors to make calling them automatic. C/PC-DOS replaces all the vectors after a job finishes executing incorrectly.

PC Mouse doesn't work (uses interrupt handler)

SideKick doesn't work (uses interrupt handler)

Norton Utilities didn't work

The Norton Utilities main program NU.EXE came up with an Error 1 when reading the disk information using relative sector addressing with Absolute Disk Read. Peter Norton answered our letter, telling us that C/PC-DOS replaces all the vectors after a job finishes executing correctly.

Printers

Absolute Disk Read. Peter Norton answered our letter, telling us that C/PC-DOS replaces all the vectors after a job finishes executing correctly.

Printman - C/PC-DOS's version of PRINT in PC-DOS.

Printman sets up a background print queue, manages the performance of the print queue and allows you to change the default page length, margins, tab, value, etc.

Stop - displays the programs currently running in all windows and allows you to terminate them. STOP also shows the total memory available in the system for more windows or programs.

Suspend - since many PC-DOS programs write directly to the screen buffer, PC-DOS provides a mechanism to subdue other processes running in background windows. Set SUSPEND to ON if your application is well-behaved, or uses the Interrupt IOh screen printing functions. This will allow your .EXE and .COM program to continue running in the background while you do other tasks in other windows.

Bundled software

C/PC-DOS includes some software not ordinarily distributed with PC-DOS, including a full-screen editor, cardfile, communications program and interactive file manager.

DREDIX - is a full-screen text-editing program used to create or modify batch, program or
word-processing files. DREDIX can work on up to four files at the same time. Each file is assigned a buffer, and you can switch between these buffers easily. Although four files can be referenced, only a maximum of two can be windowed on the screen at the same time. Most of the commands that do things in DREDIX are combinations of the Alt or Ctrl key with a letter key. For example, a comprehensive help screen can be called up with Alt-H.

Feature-wise, DREDIX is a great replacement for the shallow EDLIN program supplied with PC-DOS. Unfortunately, using an IBM color card, the screen flickers annoyingly whenever a character is typed; after each typed character, there must be at least 20 flickers. It appears that any action on the keyboard triggers the flicker.

CARDFILE - helps you store and retrieve name and address information on electronic card file. You can enter the first and last name, business address, phone number, and any comment for each associate you want on file. Once entered, commands in CARDFILE allows you to search for matching cards by name, business or phone number and display them one at a time. DRTALK - C/PC-DOS's version of PC-TALK. Using this comprehensive communication package, you can communicate with other systems, upload or download files using binary (XMODEM) or line-oriented protocols. Communications parameters can be set while inside DRTALK which overrides any settings in SETPORT. The dialing directory can be customized to include your most-used phone numbers.

FM (File Manager) - takes the most common computer commands and lists them in a menu. You can select commands from the menu with a few keystrokes. In a default C/PC-DOS system, the file manager can be selected from the startup menu. FM will be useful for those who might be unfamiliar with the C/PC-DOS command structure.

DOCUMENTATION

All end-user documentation is contained in a single ring binder. It consists of Installation Notes, a User's Guide, and a Getting Started section. All the sections are dense and lengthy with small print and only a few illustrations, but the writing is clear and the manual is certainly exhaustive.

Within the User's Guide is the bulk of information. The File Manager, DR Talk, DR EDIX Editor, the Cardfile application, the Printer Manager and the Menu creation and modification programs are each described in a separate chapter. In another chapter, the commands that operate under C/PC-DOS are listed alphabetically. This takes a full 116 pages, with about 1/2 page to 4 pages per command. Typical of DR manuals, everything about C/PC-DOS is included SOMEWHERE, but it is not always organized or indexed usefully.

An appendix to the user guide provides a helpful list of Required Program Files for the start-up and file manager menus, an ASCII table in decimal and hex, and 53 pages of error messages. An additional User's Guide Supplement lists the software that has been checked for proper operation under C/PC-DOS, including special notes on needed modifications. See later for compatible software listing.

Getting Started with Concurrent C/PC-DOS coaches the beginning user in how to install the system and back up the source disks, use of the File Manager utility, how to use and change the windows, what programs are bundled with the software, and how to get interactive help.

The end-user volume outlines the concepts of C/PC-DOS and describes the commands, utilities and programs included; it does NOT explain how the operating system actually works. These tidbits are left to a separate set of Programmers Guides. You can order this Programmer's Pak directly from Digital Research for $75.00. It consists of two fat volumes: Concurrent CPM Programmer's Guide and DR Assembler Plus Tools (see sidebar).

SOME FINAL THOUGHTS

Digital Research has been struggling for some time to regain the momentum it lost when C/PM was overshadowed by PC-DOS. With the introduction of C/PC-DOS, we think it's safe to say that DRI will contain some of this slide, although it certainly will not regain its leadership role.

Overseas, however, another story emerges. CP/M is still a major force, with many vendors wanting both DOS and CP/M compatibility. The result is that DRI has already issued some 100 licenses for C/PC-DOS worldwide. Of these, 30 to 35 major European manufacturers have brought C/PC-DOS to market. According Mini-Micro Systems (March 1985, pg. 68), the following manufacturers offer C/PC-DOS as well as MS-DOS for their computers:

- Ericsson Information Systems division of L.M. Ericsson AB
- Ferranti Computer Systems Ltd.
- Olivetti SpA
- Siemens AG
- Applied Computer Techniques Plc. (ACT)
- ICL Plc.
- British Telecom Merlin Ltd.

Therefore, we can expect DRI and C/PC-DOS to continue to prosper, regardless of its impact in the American market.

However, in America C/PC-DOS does face stiff competition from other windowing programs, particularly IBM's Topview. The weak points for C/PC-DOS are its slow performance and absence of any feature to transfer data between applications. As these other products mature, the window of opportunity for C/PC-DOS will start to close unless substantial improvements are made.

In the multi-user area, C/PC-DOS is too weak a product to last before the onslaught of networks and UNIX-based systems that are emerging to run on PC, AT and S-100 systems. Once again, the market window will be very brief.

One particular problem that DRI will face with C/PC-DOS is wooing software developers to the product. Developers familiar with PCs will likely stick to familiar confines of MS-DOS, waiting for new power from upwardly compatible improvements, rather than switch back to CP/M.
It has been about a year and a half since my review of Turbo Pascal version 1.0 was published in MicroSystems Magazine ("The Versatile Turbo Pascal", February 1984). In that time, over a quarter million copies of Turbo Pascal have been sold.

International Data Corp., a major market research firm, recently predicted that Pascal, or a Pascal-like language such as Modula-2, will begin to replace BASIC as the primary programming language for users of PCs this year. He credited Borland's Turbo Pascal with being "the prime motivating factor in Pascal's imminent rise in popularity."

In the meantime, Borland International has been busy creating other high quality, low cost products for microcomputer users. Borland has released SideKick and SuperKey as well as upgrading Turbo Pascal to version 2.0 and releasing Turbo Toolbox and Turbo Tutor.

Proving that we can expect the unexpected from them, Borland surprised many Turbo users by releasing an even more powerful Turbo Pascal version 3.0 in March. Turbo 3.0 claims to offer even faster compilation and execution than its forerunner, version 2.0. In addition, a number of new features have been added to the 16-bit version of the product, including:
- DOS 2.0 path support and I/O handling
- Turtle Graphics (IBM PC Version)
- Enhanced graphics support
- Optional 8087 and BCD arithmetic versions (16-bit)
- Improved file handling functions, including APPEND
- All known Turbo 2.0 bugs and problems have been fixed

One unwelcome change in Turbo 3.0 is its price - increased $15 from the $54.95 (including shipping) for version 2.0 to $69.95, but it is still a terrific deal. Unfortunately, version 2.0 is no longer being sold, so new users will have no choice but to buy the new version.

For many of the estimated 300,000 Turbo Pascal owners, the question is "Should I upgrade?" Borland offers an attractive upgrade incentive - just return your distribution disk for version 2.0 and Borland will credit you with $39.95 toward Turbo version 3.0 (or if you have the 8087 version, you will be credited $59.95 toward an enhanced version - 8087, BCD, or both). This offer expired on June 1, 1985.

Although the many benefits of upgrading are obvious for PC-DOS Turbo users, CP/M Turbo 2.0 users may wish to review the new features section below before deciding on an upgrade.

**NEW MS-DOS VERSION FEATURES**

In addition to its increased speed (discussed below), Turbo 3.0 for the PC and 100% compatibles has many powerful additions. Borland certainly didn't "leave well enough alone."

It now includes standard procedures for directory access and manipulation. In addition, file names may now contain drive/subdirectory information, thus a file name like 'C:\mydirectory\myfile.dat' is now legal.

Full I/O redirection on standard files is provided. The run-time package also uses standard MS-DOS file handles. Of course this means that Turbo 3.0 will only run with MS-DOS 2.0 and later. There are a number of system-interface procedures for getting command line arguments, defining a path for TURBO overlays, etc. The installation program allows defining a path for the Turbo message overlay as well.

There are a number of advanced graphics functions - for generating circles, fill patterns, etc. - as well a very nice implementation of Turtle graphics.

In addition, you can change file buffer sizes, open a file for append, and text I/O is considerably faster - especially with larger buffer sizes - and a number of new procedures are available for manipulating text files.

The distribution disk still includes the CALC.PAS example spreadsheet program, one of the most interesting programming examples I have seen to date.

**8087 SUPPORT VERSION**

Turbo 3.0 is also available with 8087 math co-processor support, as was Turbo 2.0. This version is designed primarily for number crunching applications (scientific, etc.) and provides dramatically increased speed and 16-digit accuracy over a range of 1.9E-307 to 1.67E+308. It uses the long-real 64-bit data type of the 8087 chip.

**NEW BCD REALS VERSION**

A new optional version of Turbo 3.0 supports Binary Coded Decimal (BCD) real numbers instead of the standard binary reals in the normal Turbo package. Using BCD reals provides a significant increase in accuracy and virtually eliminates rounding error - making this version attractive for developing business accounting software packages. The range of the BCD reals is 1.0E-63 to 1.0E+63 with 18 significant digits.

Several numeric and string formatting procedures are included to simplify screen and printout design, much like the PRINT USING feature of BASIC. BCD reals occupy 10 bytes compared to 6 bytes in standard MS-DOS Turbo 3.0.

**NEW CP/M-80 VERSION FEATURES**

Here's a summary of what CP/M-80 users get when they update from Turbo 2.0 to 3.0, as described by a file on the CompuServe Borland SIG: "You get an entirely new, rewritten
All Bugs Fixed?

According to Borland, all known Turbo 2.0 bugs and problems have been fixed in 3.0. However, there is at least one bug and an irritating problem that are new with Turbo 3.0.

The new bug has to do with an error in the FileSize function and a work-around fix has been published.

The new problem is that the Turbo 3.0 compiler always leaves the CGA in BRIGHT YELLOW when it exits to DOS. No fix is available. Compiled programs will leave the CGA in the last mode and color specified upon return to DOS.

Not 100% Compatible

Some programs written in Turbo 2.0 will not function the same (or in some cases not function at all) when compiled with version 3.0. First, PC-DOS and MS-DOS versions no longer work with DOS 1.X.

On the simple side, Turbo 3.0 no longer automatically clears the screen at the beginning of a program, and the program’s termination no longer places the cursor at the beginning of line 25.

Turbo 3.0 uses a different EOLN function that handles keyboard input differently, which means that some INKEY$ like routines using EOLN(Kbd) will no longer work.

Users of Turbo Toolbox will find that an upgraded ACCESS3.BOX file is included with Turbo 3.0 to allow the new compiler to be used with the Toolbox - an indication that upward incompatibilities can be a real problem.

Documentation

The 376 page typeset reference manual is a comprehensive guide to Turbo 3.0. However, there are a number of errors in the manual, most of which are noted in a READ-ME file on the disk. One major topic I found lacking was a discussion of the differences between Turbo 2.0 and Turbo 3.0 to aid in upgrading existing programs. It looks like users must use trial and error to try and debug any problems running Turbo 2.0 programs under the new version.

Speed

One of the major reasons for buying Turbo Pascal has always been its speed. Turbo 2.0 was at least 10 to 20 times faster than other Pascal compilers. Execution speed was also 3 to 10 times better than other compilers. Turbo 3.0 goes even farther to break the Turbo speed barrier.

The Turbo Editor screen display code has been rewritten to make screen updates virtually instantaneous. The “flash and flicker” that sometimes occurs when using the IBM CGA card is notably absent with the new Editor. With the improved editor and even faster compilation speed, the Turbo 3.0 programming environment really does “work like magic”.

Compiling with Turbo 3.0 really is twice as fast as with version 2.0! Several large test programs were compiled in both versions and the results were consistent. On the IBM PC, the 731 line TPLO.PAS compiler from Niklaus Wirth’s book Algorithms + Data Structures = Programs compiled in 23 seconds with Turbo 2.0 and 12 seconds in version 3.0. The 1257 line CALC.PAS example spreadsheet program provided by Borland on the distribution disk compiled in 29 seconds with version 2.0 and in 15 seconds with version 3.0. I noted that loading program files from disk into the compiler was also somewhat faster, especially when using floppy drives.

Compiled code was between 416 and 512 bytes smaller in version 3.0, with the code size decrease varying between 4.6% and 2.7%. This non-linear decrease seems to indicate that the standard library functions which Turbo 3.0 includes in each program, are somewhat smaller, rather than a decrease in the size of compiled program code itself.

Several tests with text file input/output indicate that Turbo 3.0 is consistently 15.6% faster than version 2.0 on the IBM PC with a hard disk and standard buffer sizes, probably due to its use of DOS 2.0 file handles. This improvement increases with increased buffer size, now allowed in Turbo 3.0. A simple disk I/O intensive test filter program which reads text files character-by-character and writes each character to a new file showed a 6 second improvement from 2.0 to 3.0 on a 25,229 byte file (38 seconds with 2.0 and 32 seconds with 3.0). When a 126,336 byte file was processed by the same program, an improvement of 28 seconds was noted, from 179 seconds in 2.0 to 151 seconds in 3.0.

On programs that are not real number arithmetic intensive, no speed improvement in Turbo 3.0 execution was found, other than that accounted for by the improvement in file handling noted above.

I entered the 179 line "Guass-Seidel" program for the simultaneous solution of linear equations from Alan Miller’s book Pascal Programs for Scientists and Engineers that Borland refers to as an execution speed benchmark in their 3.0 advertisements, and ran Miller’s specified example, but was unable to duplicate Borland’s published results. After modifying the program to remove intermediate screen displays and to include a DOS timer function, I found that Miller’s example of a three equation electrical current problem using a relaxation factor of 1.0 (requiring 20 iterations) took 1.21 seconds to solve with Turbo 2.0 and 0.66 seconds to solve with Turbo 3.0 and the same problem using a relaxation factor of 1.8 (requiring 44 iterations) took 3.08 seconds to solve with Turbo 2.0 and 1.49 seconds to solve with Turbo 3.0. Since no file I/O was involved, this represents a 2 to 1 improvement in execution speed - an improvement that appears to remain linear as program iterations increase.

(continued on page 84)
COHERENT is an operating system sold by the Mark Williams Company, a small software house started in 1976. Like most such shops they've concentrated on OEM sales, where they seem to have done well—for example, COHERENT will be bundled with a new Z8000 workstation just announced by Commodore for sale in Europe. In 1983 they broached the end-user market with an IBM PC version of COHERENT.

I've used COHERENT often over the last two years. It's a UNIX lookalike: it looks and acts like the Seventh Edition of UNIX released in 1979, but it's homegrown, written without reference to the code from AT&T Bell Labs.

The system tested here is COHERENT 2.3.39. The testbed was an IBM PC XT with 512K RAM and a ten-megabyte Seagate disk. (According to Mark Williams this version will also run on a COMPAQ+ or on PC's with hard disks by Corvus, Davong, Micronetworks, NCR and Tecmar.) For a multiuser, multitasking system, COHERENT is quite small. The root files take up about two megabytes of disk space, plus half a meg for swapping, and the kernel needs only 78K of RAM.

Version 2.4, due out later this year, will include some enhancements and utilities now in test. The update policy is reasonable: to get the latest version, send back the old diskettes with a check for 10% of the new version's cost. COHERENT is priced well below competitors like VenturCom's VENIX and Microsoft's XENIX.

BRINGING UP COHERENT

COHERENT comes in a packet of seven diskettes, six for the root files and one to build the system. Instructions in the release notes are straightforward; I read them over once, then went through them step by step and had a working system built in half an hour. The directions are so clear that any novice should be able to follow them. New users may not always understand what it is they're doing, but following the examples will give them a sensible system.

A Low-cost Multiuser UNIX Look-a-like for the XT & XT compatibles

DOCUMENTATION

COHERENT 2.3.39 arrived with eleven pounds of documentation, packaged in two oversize three-ring binders. The documents are bulky but nicely laid out and well organized. A typeset version in IBM PC size is due shortly, but the difference is only cosmetic. Here are the titles:
- be Calculator Language Tutorial (27pp + index)
- COHERENT Administrator's Guide (57pp + index)
- COHERENT Assembler Reference Manual (35pp + index)
- COHERENT Command Manual, Revision 3 (228pp + index)
- COHERENT System Manual, Revision 3 (175pp + index)
- COHERENT Version 2.3.39 Release Notes (77pp + index)
- ed Interactive Editor Tutorial (66pp + index)
- An Introduction to ELLE (36pp + index)
- Introduction to the COHERENT System (91pp + index)
- learn User's Guide (26pp + index)
- lex -- Lexical Generator: Tutorial (28pp + index)
- m4 Macro Processor User's Manual (15pp + index)
- nroff Text Processor Tutorial (64pp + index)
- Shell Command Language Tutorial (40pp + index)
- The TROUT Full-Screen Editor, Version 1.3 (29pp)
- yacc Parser Generator Tutorial (37pp + index)

Until very recently most UNIX lore was transmitted from druid to druid by oral tradition. The Mark Williams people seem to have understood that COHERENT users may not have druids handy. They've written an excellent suite of manuals aimed at intelligent readers who need to know how to install and administer a multiuser operating system. The emphasis is on examples and tutorials, which is all to the good. The reference sections are generally on a par with those in the standard UNIX user's manual, but the tutorials outshine any UNIX tutorials not written by Brian Kernighan. I especially appreciated the easygoing, take-my-hand introductions to lex, awk and yacc. Users learning those tools, like student skydivers, need all the hand-holding they can get.

Apart from the reference guides the most important documents are certainly the Release Notes, the Introduction to the COHERENT System, and the Administrator's Guide. With the slight exception noted below under Communications, these three manuals tell new users exactly how to install COHERENT, get it up and running, and maintain it in a multiuser environment. They can and should be read through from beginning to end, like a novel.

Here's a sample of the 2.3.39 release notes:

Adding new users

To add new users john and mary to your COHERENT system, use the newusr command:

```
/etc/newusr john mary
```

newusr will create home directories for john and mary in the directory /u. If you have a partition for users' directories (/dev/hdl in the example given above [and not shown in this review]), before you use newusr for the first time, you should be sure that /u is mounted with the command

```
/dev/hdl /u
```

This will put the user files into the partition hdl. To make sure that /u is mounted whenever you boot the system and go to multiuser mode, put the
command to mount it into the file
/etc/rc. newusr also creates a .profile
file for each new user. When john’s
.profile is created, all it will contain is
the line
export PATH=/u/john/bin$PATH
See the documents Introduction to the COHERENT System and sh Shell Command Language Tutorial for further information.

THE MARK WILLIAMS HOTLINE

The COHERENT documentation sets a high standard, with plenty of examples and good indexes, but the time may come when what you need to
know can’t be found in any manual. At that point registered owners of COHERENT can call a support hotline for advice. The idea’s excellent and I
wish I could tell you how well it works, but I’ve long since blown my cover as a
reviewer of COHERENT, so my technical questions went directly to names I knew. When I first tried the product nearly two years ago, the staff politely and patiently answered my
questions before they could know I was a reviewer. There’s no reason to think that attitude has changed.

THE PROGRAMMING TOOLS

UNIX is a development system at heart, and COHERENT provides nearly all the usual development tools. lex and yacc are there, as well as awk and m4, and the obligatory C compiler. The only omissions worth mentioning are the Source Code Control System (too big to fit), the syntax checker lint, and the pretty-printer cb.

In a sense COHERENT’s most important development tools are its system calls, which are identical to those of UNIX 7, and its C library, which is complete unless you need exotica like the double-precision log-gamma function. According to Mark Williams, C programs that run on UNIX 7 will run on COHERENT after recompiling, and I think that’s true if you take it with a grain of debugging. After all, it’s seldom possible to move code from UNIX on computer A to UNIX on computer B without fixing a few glitches, especially if the program’s a large one and the coders took a few shortcuts. (They always do.)

Even shell scripts can often be moved as is from UNIX to COHERENT, since COHERENT’s sh is a clone of the Bourne shell. Unfortunately, comments are limited to lines beginning with a colon; the comment symbol # would have made a nice enhancement.

Other tools don’t always follow UNIX usage one hundred percent. Suppose you want to sort filein and send the sorted output to fileout. The command line

```
sort filein -o fileout
```
works fine with UNIX but not with COHERENT, which insists on the counter-intuitive

```
sort -o fileout filein
```
It’s hard to fault Mark Williams here, since their version follows the command syntax given in the UNIX user’s manual, while UNIX doesn’t. Yet it’s a fact that a UNIX shell script with the line

```
sort filein -o fileout
```
won’t run under COHERENT. This points out a simple lesson: if you need UNIX, get UNIX. For instance, if your office or lab runs UNIX on minis, and you’d like to add PC workstations, and you expect to move the code you’re developing back and forth between minis and PC’s, you probably want a UNIX derivative that’s based on the straight UNIX code. You can still expect some portability trouble -- that’s inevitable -- but you’ll suffer less from conflicts like the one shown above for sort.

Otherwise COHERENT’s compliance with UNIX should be close enough to satisfy individual users. I’ve tested various tools by moving programs from COHERENT to UNIX and vice-versa, and by running the examples published in several standard UNIX guides. Results were good, though most code needed a little tweaking. The problems usually had to do with command syntax or the name of a library, and I was never really stymied.

Mark Williams’ C compiler is excellent. It supports the standard features described in Appendix A of Kernighan and Ritchie’s “C Programming Language”, and adds a few popular extensions -- void, enum types, structure assignment, readonlyly statics, names with up to 39 significant characters. MWC86, the MS-DOS version of this compiler, sells for the same price as the whole COHERENT package. COHERENT’s C is essentially the same as MWC86, though it doesn’t support the 8086’s large memory model, which means you’re restricted to programs with 64K bytes of data and another 64K of executable code. MWC86 can use the 8086’s whole memory space, a feature promised for a future release of the COHERENT compiler. Also promised is a COHERENT version of the symbolic debugger that’s shipped with MWC86. I’ve used that debugger and found it very helpful. With it you can debug a C program in terms of the source code, which means cutting big chunks off a project’s development time. For now COHERENT users have to make do with db, an assembly-level debugger like UNIX’s adb. They’ll also have to give up lint-- no great hardship, since the C compiler’s error-checking is unusually good, with lint-ish warnings triggered by nonportable code.

Incidentally, the C library provided for MWC86 offers most of the functions in COHERENT’s C library, even including setjmp and longjmp. That makes COHERENT a good environment for MS-DOS software design. Programs can be developed in COHERENT with UNIX-lookalike tools, then moved painlessly to the MS-DOS compiler.

TEXT PROCESSING

Text processing was UNIX’s first application, and in many offices UNIX is still used mostly for editing, formatting, typesetting and vetting text. COHERENT supports editing and formatting with the line-oriented editor ed, two screen editors, and nroff. Mark Williams does have a spelling checker, but the dictionary takes up so much room that it’s omitted in the XT distribution. Shops that do a lot of word processing may want to order it as an option.

ed is a common bond in the UNIX community. Most installations offer a screen editor of some sort, usually vi and sometimes emacs, but you can never be sure what you’ll find on a stranger’s system, or whether it will work with your screen. ed is an uncomplicated, reliable editor that works at any terminal. Personally I prefer ed to screen editors like vi, which gobble memory, run slow, and rely on keys that wander from place to place on different keyboards.

COHERENT’s ed surprised me at first by refusing blanks in command strings. That is,

```
1,23 w thisfile
```
won’t work -- you have to type

```
1,23w thisfile
```
The explanation is that COHERENT’s version allows constructions like

```
1,23wq thisfile
```
where commands are piled together. I prefer consistent syntax to multiple commands. Otherwise ed is everything it should be, and unlike many editors it will handle files larger than 64K.

COHERENT’s screen editors are trout and elle (rhymes with belly), both variants of emacs. They work quite well and should please those who like screen editors. elle offers windows, which will please those who like windows. I tried to stick with these editors long enough to overcome my prejudices, but had to give it up.

COHERENT's nroff comes with the standard ms macro package. I've used nroff heavily without problems. I do have a quibble, though. nroff's output contains control codes for underlining, boldface, and so forth, and of course these codes differ from printer to printer -- a perennial problem with word processors. Mark Williams' nroff produces the sort of plain-vanilla codes that drive a Diablo or Qume printer. Since many PC's were sold with the Epson MX80 dot-matrix printer, a filter called epson is provided to reshape the output. Just type nroff -ms myfile and formatted output goes to the printer.

This works perfectly for the MX80, but my XT came with a slightly different Epson, IBM's "Personal Computer Graphics Printer," which doesn't support the MX80's italics. I noticed this problem in the earlier edition of COHERENT and wrote a filter to get around it. It's still a problem in 2.3.39.

COMMUNICATIONS

Over the years communications and networking have become very important to UNIX. From the beginning dialup ports were provided for remote access via phone lines and modems. Then utilities were added to ship data from one system to another, and an informal network of UNIX sites began to take shape. There are well over a thousand nodes in the UNIX network, and the traffic in electronic mail and news articles is heavy enough to cause concern -- a busy site can run up four-digit phone bills. The mail system's ease of use is seductive, and most of us still get a ham-radio thrill out of sending notes to Europe or Australia. The utility programs that make all this happen are known as the uucp group, and they're invisible to most users. UNIX calls them out secretly, often late at night, and keeps the details to itself -- which is just as well, since those details are ugly. Communicating via UNIX is a pleasure, but the communications utilities are hard to write, debug and maintain, which may explain why no version of COHERENT has offered uucp so far. However, 2.3.39 includes an effective system-to-system communications package, and this provision is made for dialup lines.

Installing a COHERENT dialup is easy. The XT comes with an asynchronous port and an RS-232 connector. Attach a Hayes-compatible modem, amend the /etc/ttys file to identify the port and set its baud rate, and you're ready to go. I should say that I had some trouble with this step because COHERENT 2.3.39 names its devices differently from the version I was used to, and for once the documentation didn't help. I worked this out with Mark Williams' technical staff, and they rewrote the release notes to make installation easier.

For inter-site data transfer there's kermit, COHERENT's version of the widely used communications package. It's a well-developed piece of software and worked perfectly when I tried it. With it you can dial in to any on-line system, using your XT as a dumb terminal. If that system also has kermit, you can transfer files. kermit's error-checking protocols allow you to send and receive both ASCII and binary files with good confidence, even over normally noisy phone lines at 1200 baud. Unfortunately these file transfers can be done only between kermit systems -- since I have kermit you can use your kermit to send files or to get files from any system, but you can't load up or down to a system that doesn't support kermit. By the way, despite its...
name kermit is anything but cuddly; novices won’t find it easy to use. One of Mark Williams’ good tutorials is needed here.

Now for the good news. A future release of COHERENT will include the uucp utilities. The software is just going into test, but it does exist and it does work. Mark Williams sent me a prerelease copy, which I’ve used to communicate with other COHERENT and UNIX sites. This uucp, written by Lauren Weinstein, is functionally similar to the UNIX standard and should greatly enhance COHERENT’s appeal. The eventual release will also supply cu, a dialup utility that lets you share ASCII files with non-kermit systems.

PERFORMANCE

The PC XT has never been a speed demon and wasn’t meant for multitasking. It’s certainly the least workhorse you’d want to saddle with timesharing, and UNIX sits heavy on it. True, the first versions of UNIX ran on even smaller hardware, but that was ages ago by the digital clock. Nowadays a middling UNIX shop may put fifteen or twenty users on a PDP-11/70 or a VAX, and no software can make a VAX out of a PC.

COHERENT certainly squeezes a lot of work out of a little computer, but here as in the old saw, two’s company and three’s a crowd. A 512K XT will reasonably serve three COHERENT users, one at the console and two at terminals hung onto the async ports; when memory falls short tasks are swapped out to disk, so no job will fail for lack of space unless the disk is full. But if all three users do heavy work --nroff jobs, for example, or compiles, or number crunching -- then response time will exceed the threshold of boredom. A two-user setup seems more reasonable, and that’s how I tested COHERENT, with the second user dialing in through a U. S. Robotics modem.

In the two-user configuration I found response no worse than what I’m used to on a twenty-user 11/70, though disk-heavy jobs can always slow you down. Here are some timings that compare COHERENT on the XT with VenturCom’s VENIX, and with UNIX or UNIX clones running on two new micros and a VAX.

The first benchmark does ten thousand system calls and barely touches the disk:

```c
main0{
  int i;
  for (i = 0; i < 10000; ++i)
    getpid();
}
```

Here are the timings:

- DEC VAX 11/780, UNIX 4.2 BSD: 2.4 min
- IBM PC AT, VENIX: 3.0 min
- AT&T UNIX PC, UNIX V: 3.2 min
- IBM PC XT, VENIX/86 2.0: 8.4 min
- IBM PC XT, COHERENT 2.3.39: 1 min

That’s a little artificial, of course -- real jobs move data. So I tried another benchmark, one that leans heavily on nroff and exercises programming tools like awk, sed, sort and the shell. It formats a 24K text file, searches it for five keywords, and prints an index with page numbers. Here’s the shell script:

```bash
: Script to index keywords in an nroff text.
: Usage: index nroff-file-name keyword-file-name
;
: Use sed to turn keyword file into an awk prog file
sed "/'" | $2 > $2
: Add null prog to print all lines
echo "" > /tmp/__x$$
```

Micro/Systems Journal July/August 1985
And here are the timings:

<table>
<thead>
<tr>
<th>System</th>
<th>Timings</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEC VAX 11/780, UNIX 4.2 BSD</td>
<td>62.9</td>
</tr>
<tr>
<td>AT&amp;T UNIX PC, UNIX V</td>
<td>65.3</td>
</tr>
<tr>
<td>IBM PC AT, XENIX</td>
<td>88.9</td>
</tr>
<tr>
<td>IBM PC XT, COHERENT 2.3.39</td>
<td>200.3</td>
</tr>
<tr>
<td>IBM PC XT, VENIX 2.6</td>
<td>210.5</td>
</tr>
</tbody>
</table>

(All timings are in cpu seconds, user + sys. The UNIX PC was tested with the 10-megabyte disk.) I think those tests justify two general conclusions. First of all, COHERENT is a bargain for XT owners, who can convey the feel of a minicomputer UNIX to two users for $500. (In fact, if a mini's users are numerous and busy the real turnaround time for a job might be better on the XT.) But -- conclusion number two -- UNIX fans looking for a new computer will find a still better bargain in the likes of the PC AT and the AT&T UNIX PC, which cost less now than I paid for my XT two years ago.

I understand that COHERENT runs on the PC AT in 8086 mode, and I'm sorry I wasn't able to time it. Unfortunately Mark Williams has no immediate plans for a version that would exploit the extended features of the AT's 80286 chip, as XENIX does. Let's hope such a version is forthcoming; COHERENT on the AT could make an attractive package.

All of which brings up a point about performance that can't be measured in cpu seconds. In 1970-71 developers at Bell Labs set up the first commercial UNIX installation, a word processing system for the Labs' Patent department. It was installed on a PDP-11 with 24K bytes of core, a half-megabyte hard disk, and no memory protection, at a cost of about $65,000. Today, for much less money, you can put COHERENT or some other UNIX of your choice on an XT with 640K of RAM, twenty megabytes of disk -- and no memory protection. Chips meant for multitasking, like those in the AT and the AT&T UNIX PC, have ways of protecting memory so no program can accidentally destroy another. The XT's chip does not.

Writing of the first PDP-11 installation, Bell Labs' Dennis Ritchie recalls: "On a machine with no memory protection ... every test of a new program required care and boldness, because it could easily crash the system." *This still holds true for the XT. If you run COHERENT with reliable applications software you'll probably have no trouble. But if you use your XT as a development system, whether with COHERENT or any other OS, sooner or later you'll write a program with a bug that causes a crash. "Sooner or later" is a figure of speech: most programmers will have the problem sooner, not later, and more than once on bad days.

If you're alone on the system such crashes are merely annoying. COHERENT is robust, and I've never had a crash I couldn't fix with a reboot and the check -s command. But if there's a second user, who's probably doing your monthly billing -- well ...

**COHERENT AND MS-DOS**

COHERENT and MS-DOS can coexist in a strictly physical sense. Installing the system involves partitioning the XT's disk into sections -- one for the root files, one for users' files, and so forth -- and the release notes explain how to set up an MS-DOS partition so you can boot the MS-DOS operating system. However, you can't jump back and forth between MS-DOS and COHERENT; you'll have to shut one down completely before you can start up the other. The only communication between the two systems is by diskette. COHERENT comes with utilities that read and write diskettes in all the XT formats.

**THE BOTTOM LINE**

There's a feeling of rightness about COHERENT that's hard to quantify, something to do with appropriate technology. That's a '70s catchphrase, and perhaps I can sum up my feelings by saying that COHERENT reminds me of UNIX in the '70s, before it took on so many responsibilities and put on so much weight. COHERENT works as advertised, it's well documented, and it doesn't overload the PC's little-league chip. If you own a PC with hard disk and want the functionality of UNIX, COHERENT is a bargain. It will be an even bigger bargain when Mark Williams adds uucp.

* D. M. Ritchie, "The Evolution of the UNIX Time-sharing System," AT&T Bell Laboratories Technical Journal, October 1984. All articles in this number of BLTJ deal with UNIX and are highly recommended.
The PC Bus

by Dave Hardy

Editor’s Note: The “PC-Bus” is used today by over 200 system and plug-in board manufacturers. It is today a de-facto standard for most single-user systems. I feel that many of our readers are interested in developing special purpose hardware to systems using this bus and hence I asked Dave Hardy to write this regular column.

Many IBM-PC and PC-compatible computer users are surprised to find out how easy it is to add peripheral devices to their machines. In spite of the fact that the PC is a rather complex microcomputer, it is designed to allow all kinds of additions to its bus, from simple I/O like game ports to complex DMA circuits like hard disk controllers and video graphics boards.

Even more surprising to most PC users is the fact that add-on boards are simple, and can be broken down into three parts to help understand its operation: The address decoder, the I/O decoder, and the bus interface.

The I/O Channel

Although the IBM-PC is basically a single-board computer, provision has been made to add additional devices via a series of 62-pin connectors called the “I/O Channel.” The I/O channel is simply an extension of the data, address, and control busses of the PC's 8088 microprocessor. Along with the 8088's 8-bit bidirectional data bus, its 20 bit address bus, and associated control lines, the I/O channel also contains 6 of the PC's 16 interrupt lines, 3 of its 4 DMA lines, a separate high-speed clock (along with the system clock, of course), a Power-On Reset line, a Wait line, and several others.

The I/O channel also provides enough power (+5V and +12V) to run most boards. The standard PC has five expansion connectors and the PC-XT has eight, although two or three of these slots are used for standard boards like the disk controller, video output, etc.

Figure one shows a diagram of the PC's I/O channel (a.k.a. expansion slot).

For a full explanation of the PC's I/O expansion lines (and a dandy do-it-yourself reference), you might want to pick up a copy of the IBM Technical Reference Manual. It probably contains everything that you'd ever want to know about the hardware inside the PC, along with all of the information that you'd ever need to interface to the PC's I/O boards. There are very few books written about designing and building boards for the PC, and the reason why may be that the Technical Reference manual is complete enough that additional books are not necessary.

Some Pin Definitions

Fortunately, only the most complex expansion boards would ever need to use all of the pins in the PC bus. (This is where it starts to get easy.) In addition to the address and data lines, most simple I/O interfaces to the PC (like the simple parallel I/O port shown in figure one) require only 3 control lines: IOR*, IOW*, and AEN.

IOR* - I/O Read command line. This line goes active (low) when the processor (or DMA device) controlling the system requests that data from the simple interface be placed onto the system data bus.

IOW* - I/O Write command line. This line goes active (low) when the processor (or DMA device) controlling the system requests that the simple interface read from the data bus.

AEN - Address Enable line. This line goes active (high) whenever a DMA controller has control of the address, data, and control busses.

Beside the three lines above, our simple parallel I/O board (figure 2) again needs to see the first ten address lines (AO-A9), all eight data lines (D0-D7), the +5V power line, and a ground line (GND). The reason that we only need to see the first ten address lines is that we are doing ported input and output, not memory reads and writes. Although the PC can address much more memory, it can only handle 1024 I/O ports (0-3FF, ten bits).

Figure Two Explained

Figure two is actually remarkably simple, and can be broken down into three parts to help understand its operation: The address decoder, the I/O decoder, and the bus interface.

The address decoder (the 11 Exclusives-OR gates in figure two) constantly watches the ten address lines used for ported I/O and sends the signal SELECT (active high) to the I/O decoder whenever it sees an address that matches the one set in the 10 switches. IBM set aside port addresses 300H to 31FH for use with its prototype board, so it might be a good idea to use one of these addresses for our simple parallel interface. Address 300H, for example, could be selected by closing switches A9 and A8.

The address decoder also watches the AEN line to make sure that the address it is seeing is a valid processor address, and not something pumped out by a DMA device that has taken temporary control of the PC's address bus.

The I/O decoder watches the IOR* and IOW* lines to see if an I/O read or write is taking place. If it sees the SELECT signal at the same time as it sees an I/O read or write, then it assumes that the processor wants to read from it or write to it, and asserts the proper line (either GATE* or LATCH).

During an I/O read, the 74LS244 Octal Buffer IC is activated by the GATE* signal, and places data from the DATA INPUTS onto the PC's data bus so that the PC can read it.

During an I/O write, the 74LS374 Octal Flip-Flop IC is activated by the LATCH signal, and latches the value on the PC's data bus into its DATA OUTPUTS.
The circuit shown in figure 2 could be even simpler if the address were hard-coded, instead of being switch-selectable, and the whole thing could also be done with fewer IC's, too, but I have left it in its unreduced form to make it easier to understand. It is easy to see, in its present form, how this circuit could be expanded into something more useful, such as a parallel printer port, or serial communications port, or game port.

In future "PC Bus" columns, I hope to discuss many of these applications, along with some of the more complex features of the PC's I/O channel, including DMA circuits, memory expansion (how about 200MB with bank select?), parity circuits, and even a front panel/hardware debugger for your PC.

As always, I welcome reader questions, comments, and suggestions, and will attempt to answer as much mail as possible each issue. If you have any input at all, please feel free to send it to me at any of the following addresses:

CIS: 70150.102
SOURCE: TCH054
Technical BBS: (313) 846-6127

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The UNIX File looks at many aspects of the UNIX operating system. If you have comments or questions about UNIX or this column, feel free to write to Ian Darwin at Box 603, Station F, Toronto, Ontario, Canada M4Y 2L8. If you have UNIX mail access to the UUCP network, you can contact me at "ihnp4!darwin!ian". I can’t always answer immediately, but I will get back to you (electronic mail gets answered first!). And I’m always glad to hear from readers with comments either on The UNIX File or on their reactions to particular UNIX systems or products.

This issue’s column discusses a name and address database written using only the UNIX shell, a UNIX word processing book, some comments on C programming style, and a pointer to some other UNIX articles.

MAILING LIST SYSTEM

I talk a lot about shell programming as a means to portability and ease of maintenance. Here’s a mailing list system of moderate complexity, implemented without writing any C programs. If you have a commercial mailing list program (such as Leverage, reviewed in Microsystems, August 1984, page 122), the editing will be faster. My file format is intentionally compatible with Leverage and other UNIX-conscious programs using ASCII files to store the data.

All the files for the system are kept in a subdirectory called ‘nad’ for name and address data. The main file is called ‘database’ (for Leverage compatibility; otherwise any reasonable name would do). File DATABASE has one line per person or company, with a dozen or so fields separated by the vertical bar character. The inestimable advantage of this format, as opposed to any binary organization, is that most any UNIX program can handle it with ease. You can SORT, GREP, AWK or EDIt the file anytime. Here’s what my own record might look like:

```
darwinIan|p|y|Box 603, Station F|
Toronto|ON|M4Y 2L8|416-555-1212|416-555-1212|416-555-1212|
unifilefile@email@darwinian
```

That’s all one line, but it’s been broken up to make it fit in a narrow column. What are the fields, and what order to they appear in? I’m glad you asked, for I have in a file called LAYOUT an AWK-language description of the fields:

```
NAME=0 +1 # surname
GNAME=SNAME+1 # given name
LIST=NAME+1 # which mailing list?
XMAS=LIST+1 # is this slug for xmas card?
ADDR =NAME+1 # address
ZIP = ADDR +1 # zip code
PROV = investments +1 # state/province
ZIP = ADDR +1 # state if U.S.A.
EMAIL = NAME+1 # e-mail name.
```

That gives an AWK name to each column: NAME for surname - column one, GNAME for given names - column two, and so on. The slightly-roundabout way of assigning the numbers is so that I can add or subtract a field without having to tediously renumber all the rest, an example of letting the computer do the walking.

How do I get the data into the computer? Naturally, there’s another shell script. It’s called ‘bp’, and here’s how it looks in action:

```
% bp
NAME? Darwin
GNAME? Ian
LIST? p
XMAS? y
ADDR? Box 603, Station F
CITY? Toronto
PROV? ON
ZIP? 416-555-1212
PHONE? 416-555-1212
FONE? 416-555-1212
EMAIL? email@address
ENICN? 1234
XMAS? s
```

This prompting, while not as sophisticated as a full-screen product like Leverage or dBASE, is adequate for low-volume work. Note that BP’s main loop is built entirely of shell-programming primitives, and isn’t very long:

```
for f in NAME LIST XMAS ADDR ...
do
echo -n "$f" 
 done
```

You will recognize that the names here are the same ones in the file LAYOUT; in fact I just read the layout file into the editor and deleted everything except the names, then joined them together into a single (long) line (shown here as ‘...’ due to column width). The keywords FOR, DO and DONE delineate a simple programming loop; the variable $ is given the value NAME, LIST, and so on. The variable is echoed (sans newline; if you have a System III/V ECHO command use ‘c’ instead of ‘-n’), then a response from the terminal is READ into the variable named by the variable $. So after the whole loop has been through, there are shell variables NAME, GNAME, LIST and so on, each with some reasonable value. To add them to the file, we just ECHO them all onto the end of the file:

```
 echo $NAME |$GNAME |$LIST | $XMAS |$ADDR...
```

The first part of BP contains some checking and some special handling for the first prompt. This allows me to flip into the editor just after finishing entering a record if I see I have made a mistake. Alternatively, I can use the shell escape mechanism to perform any other task that might occur to me while my fingers are tied up and my mind is free. Listing one shows what the entire BP program looks like.

I don’t make any special provision for editing the data. I use a text editor to update the file; this is serviceable but not as flashy as LEVERAGE. (A challenge for the technical reader is to write a program that lets you update fields on some full-screen basis. It must read a description of what the fields are, rather than knowing that the E-mail nickname is field 11, and it must use termcap and curses to update the screen. This is probably a term-length programming project; do not undertake it lightly.)

Now what do I do with the data? I have so far developed programs that consult it for an online telephone directory, keeps my .MAILRC file (the place where several mail systems look for mail aliases) updated, and prints my Christmas Card list. Here’s the phone program:

```
! phone - find name in the phone book
CASEOPT= -y in V7, broken in III/V, 'fixed'
to -i in V2?
```
for person
do grep $CASEOPT $person ${PHONE
BOOK-$HOME/nad/database}
done | awk -F'1' '^
BEGIN { SNNAME = 0 +1 ; $ surname
rest of file LAYOUT included here
}
print $NAME, $SNNAME, "- Home:"

$SFONE,"Work:" , $BFONE }
'

What's this thing with brace
brackets in the GREP command? The
 Bourne shell (sh) allows you to provide
defaults for shell variables; the variant
shown here allows me to have a shell
variable PHONEBOOK (presumably
set in my .PROFILE file) that would
override the value given here. The
GREP command will look in my
PHONEBOOK file if I have the shell
variable PHONEBOOK set; by default
it looks in file nad/database from my
home directory. A group of users could
share a common file such as
/USR/ADM/PHONEBOOK by setting
that as the default here. I used the AWK
program to break up the records for
printing. Use of the CUT utility on
the UNIX System (1985,
ISBN 0-07-035498-7) arrived on my desk
recently. And it is good. The book has a
brief introduction to UNIX, then A
detailed discussion of ED,
NROFF/TROFF, formatter macros,
and TBL (but not EQN). The editor
discussed is ED, not VI; this might
seem odd at first but there's a plausible
aside on why ED is the one true editor
for word processing and why none of
the less-well-documented formatter
features to be able to explain what they
do. The book contains many examples,
and illuminates not a few obscure
points. The book is just what you
wanted when introducing people to the
topic, or learning it yourself. It's here
now. If you're doing text processing
work on UNIX, get a copy.

WORD PROCESSING BOOK
Morris Krieger's book Word
Processing on the UNIX System (1985,
McGraw/ BYTE, ISBN
0-07-035498-7) arrived on my desk
recently. And it is good. The book has a
detailed introduction to UNIX, then A
detailed discussion of ED,
NROFF/TROFF, formatter macros,
and TBL (but not EQN). The editor
discussed is ED, not VI; this might
seem odd at first but there's a plausible
aside on why ED is the one true editor
for word processing and why none of
this VI or EMACS stuff need apply.

The set of macros discussed is MS, not
MM. While that might appear to be a
liability for System V users, the book
describes the principles behind macros,
so that the user of any version of UNIX
can not only understand formatter
macros, but even write new ones, based
on this material.

I can't give this book the review I'd
like to, partly because it's not the main
focus of this column and partly out of
modesty - I was consulting with Mr.
Krieger while he wrote it.

But I do recommend the book. Its
380 pages are substantially more
detailed than all the AT&T formatting
documents. Krieger has spent
considerable time trying some of the
less-well-documented formatter
features to be able to explain what they
do. The book contains many examples,
and illuminates not a few obscure
points. The book is just what you
wanted when introducing people to the
topic, or learning it yourself. It's here
now. If you're doing text processing
work on UNIX, get a copy.

FORMATTING C PROGRAMS
There is room for considerable
variety of formatting style in most
block-structured languages. In my
humble opinion, however, there are
some programs being published
throughout the C/UNIX community
that aren't attractively formatted.

Newcomers to the language often
wish for guidance in this area, and a
formatting program or "pretty printer"
can help. There are several C
formatting programs out there. To my
mind, the "best" of the lot I've seen is
CB with the -s and -j options. These
options - unfortunately not in all
versions of UNIX yet - format your
program according to the style used by
Kernighan and Ritchie in "The C
Programming Language". Since this
program works as a filter, all you have
to say is:
cb -sj prog.c >prog.new

Looking at the file layout, you'll
see that I have the nickname and full
name of the common entries is:
alias nickname fullpath
where nickname is the name you can
remember, and fullpath is the mail path
to get to them. For me, you might have:
alias unixfile lhmp4ldarwintian

Mail unixfile

I

FIGURE 1- BP shell file
and look at prog.new. If you’re happy with it, just:

mv prog.new prog.c

to replace the old version with the neatly formatted one. Look at it before replacing the original since any automated formatter can occasionally be driven berserk by certain constructs that its authors didn’t anticipate.

If you are developing C code on UNIX, please use cb -sj on your programs before you publish them or post them to the net. A uniform coding style goes a long way towards portability of both programs and programmers.

While I’m on my soap box, I’ll say my piece about block comments. Since most of us are no longer using punched cards, we no longer need such fancy block comments as

/********** DO SOMETHING **********/  
/******* DO SOMETHING **********/  

When I see one of these keypunch wonders, I wonder how much programmer time was wasted making it. It’s much easier on the eyes (and the printer) to do something like this:

/*
 * do something
 */

They both take the same amount of paper, but the latter looks better - to my eyes at least.

MISCELLANIES Back issues: Micro/Systems Journal has inherited some back numbers of the old Microsystems. The November issue, which Ziff-Davis did not send to most newstand distributors, contains several UNIX articles, including an interview with Andy Hall (in charge of System V development); a good article on C portability; a review of UNIX on the Codata 3300; and a UNIX File column discussing the make utility and a shell efficiency tip and file system reliability. Plus there’s a nine-page article on the history of UNIX that I co-wrote with Geoff Collyer. If you’re interested in UNIX, I (modestly) suggest you get a copy of that issue if they’re still available.

That’s all for now. Next month: another installment on joining the UNIX network, and how to get the source for a UNIX-like operating system subset. See you then.
100,000 software developers can't be wrong.*
UNIX is the chosen operating system for more than 100,000 software developers because it has the power they need. But developers aren't the only people who need computing power. Any business that wants multi-users to access the same files at the same time or wants to simultaneously run multi-task operations . . . needs UNIX. At Dynacomp, we offer UniPlus + * System V by UniSoft Corp. For $1495. U.S. dollars you can run UNIX on the CompuPro® 816/E™ . . . a powerful 68K S-100 bus computer system that maximizes its memory for multi-user/multi-task operations.

UniPlus + includes all the standard UNIX System V features PLUS performance enhancements found only in UniPlus +. These features increase the portability, flexibility, and performance of UNIX, allowing an affordable operating system for program development, text preparation, and general office use.

If it's time for you to upgrade to UNIX, call your local Full Service CompuPro System Center in the United States or call Dynacomp in Canada for complete details.

*AT&T estimates that there are more than 100,000 people currently developing software under UNIX. Dynacomp serves all of Canada and parts of Asia and the Pacific Rim. Call us for details and information on our full product line including Plesio. UNIX is a trademark of Bell Laboratories, Inc. CompuPro is a registered trademark and System 816/E™ is a trademark of Viasyn Corp. UniPlus + is a registered trademark of Unisoft Corp. AT&T is a registered trademark of AT&T Information Systems.

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**Conclusions**

All in all, Turbo 3.0 is certainly still a good deal. As an applications development language it is without equal for ease-of-use, price, speed, and power. Turbo 3.0's added speed and features make it well worth the $30.00 upgrade cost for existing Turbo 2.0 owners (especially for IBM PC-DOS users). It is unfortunate that the long integer type is still not supported, but the BCD package can make up for this limitation. The new manual still has a few errors, but most are noted in a READ.ME file on the program disk.

The Turbo 3.0 compiler from Borland International still represents a value without equal in high quality, low cost microcomputer software.

David W. Carroll is a freelance writer and computer consultant living in the Sierra Nevada foothills near Sacramento, California. He is the author of "Telecommunications with the IBM PCjr" co-published by Microtext/Prentice Hall and "Programming with Turbo Pascal" to be co-published by Microtext and McGraw Hill this summer.

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**Summary**

- Turbo 3.0 is a significant upgrade for existing Turbo 2.0 users.
- The compiler now supports 16-bit version 30-100% faster than PIP.
- Handles random files, disks larger than a floppy disk, and more.
- Includes new commands like change/makefile, chdir, listdir, etc.
- Offers improved portability and performance.
- Available for IBM PC-DOS, CP/M, and other systems.

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**Further Reading**

- Turbo Pascal 3.0: A Comprehensive User's Guide by Bob Ireland
- Turbo Pascal Programming by David W. Carroll

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**About the Author**

David W. Carroll is a freelance writer and computer consultant living in the Sierra Nevada foothills near Sacramento, California. He is the author of "Telecommunications with the IBM PCjr" co-published by Microtext/Prentice Hall and "Programming with Turbo Pascal" to be co-published by Microtext and McGraw Hill this summer.

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**Contact Information**

- Dynacomp: 46-6335 Mill Creek Dr. Mississauga, Ont.
- Phone: (406) 825-8002
- Fax: (406) 825-8000

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**Technical Specifications**

- Processor: 8086 Coprocessor
- RAM: 8088, small/big model support
- Memory: 128K, 256K, 640K, expanded memory
- Diskette: 3.5-inch, 5.25-inch, 8-inch
- Floppy Drive: IBM PC/DOS, CP/M, MS-DOS
- Hard Drive: Available options include 10, 15, 20Mb hard disks, etc.
- Printer: Parallel, serial, network
- Modem: 300/1200 baud rates
- Terminal: Supported
- Cost: $1495.00

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**Source**

Micro/Systems Journal July/August 1985
I'm back into magazine publishing ... something I swore I would never do again. When Microsystems magazine died I was in a depressed state for weeks. Countless letters and phone calls from devoted subscribers made it even worse. Everyone kept urging me to do it again.

I kept remembering what my wife Lennie and I went through when we started Microsystems, and I said no ... not again ... we want to live a normal life again. But there has been something missing from my life the last several months. The passing of Microsystems left a void. Let's face it, there really is no other magazine that caters to the advanced micro user the way Microsystems did.

So I am starting a new magazine. It is in the tradition of the old Microsystems. Lots of practical info ... strictly technical ... no fluff ... stuff to keep every hacker up-to-date on the ever-changing micro technology ... software and hardware tutorials and reviews, public-domain software info and reviews (SIG/M, PC/Blue, PC-SIG, C-User Group and more) ... MS/DOS, CP/M, Turbo DOS, C, Pascal, Forth, Lisp, and of course Assembler ... S-100, IBM-PC, single board computers, multi-user systems ... a real micro systems-oriented journal ... in fact, that is its name—Micro/Systems Journal!
The following back issues are available. They are $4 per copy ($6 foreign, cash, Postal Order or U.S. bank check) and include shipping. If ordering 3-9 copies deduct 10%, 10 or more copies deduct 15%. Orders can be combined with back issues or old Microsystems for discount. Send to: M/SJ, Box 1192, Mountainside NJ 07092.


MAY/JUNE 1985 (Vol 1., No. 2): Build an S-100 to PC-Bus Converter, Interfacing to MS-DOS Part 1, Loadable Drivers for CP/M2.2, Roll Your Own PC-Clone, Building Up ZCPR-3, C & Godbout Disk-1 Controller, Writing Translation Programs in C and Turbo Pascal; REVIEWS: 16-Bit Lisp & ProLog-Part II.

Microsystems Back Issues

The following back issues of the old Microsystems magazine are still available. Quantities of many of the issues are, however, limited. They are $3.50 per copy ($5.00 foreign, cash or U.S. bank check) including shipping. If ordering 3-9 copies deduct 10%, 10 or more copies deduct 15%. Make check out to “Micro/Systems Journal”, Box 1192, Mountainside NJ 07092.

1984

AUGUST: Intro to Local Area Networking; Graphics Subroutines in C For NAPLPS; Using YACC, MAKE and Prolog under Unix; Multiprocessing on S-100; Using Unix Sort, ciphers and enhancements; REVIEWS: TurboDOS, NCR-PC, MindSet-PC, Adding TurboDOS to NorthStar System, Leverage DBMS for Unix.

APRIL: Unix Software Directory; Upgrade NorthStar ZPB; MS-DOS 2.0 Overview - Part 2; S-100 Phantom & Bank Selecting; Upgrading FIG Forth; REVIEWS: UniPlus +, Informix, DRI-C.

FEBRUARY: Using WordStar to Create Mailmerge/Base-II files; Moving data files between CP/M software packages; Datestamp DBase-II; CP/M 2.2 Debugging; Building S-100 diagnostic hardware; Enhance CP/M + with RSX; REVIEWS: DBase-II, S-100 Mainframes, DRI Display Manager, AutoDex, Turbo Pascal.

JANUARY: Enhancing MP/M - Part 1; Installing MP/M; Add Concurrency to MP/M; Two Users on CP/M; Relocating Assemblers & Linkage Editors - Part 3; S-100 Wait States; REVIEWS: MP/M-8/16, ProComp-8, Paragraphics Game Board, ProLog.

1983

DECEMBER: CP/M Software Directory; A Debug Subroutine; Implement IOBYTE on North Star; Floppy Disk Problems; Improve Trig Functions in CBasic-80; Build Cheap S-100 Memory; Extended Memory Management; CP/M-86 BDOS Calls; REVIEWS: XLISP, LISP/80, TLC LISP, APC Basic, Microdynamics S-100 EProm Programmer, Ackerman S-100 Digital Synthetalker, Digital Research 16K & 32K S-100 Memory cards.

NOVEMBER: Intro to 80286, 68000, and 16032 Microprocessors; Intro to Local Area Networks - Part 2; Extended Memory Management for older S-100 Systems; Notes on Microsoft Fortran-80; Building S-100 Parallel Ports; REVIEWS: CompuPro CPU-68K, System 8/16, Xenith Z-100, Nevada & Ellis Computing Fortran.

OCTOBER: Intro to Local Area Networks, Part 1; Build Low-Cost LAN; Build S-100 Bubble Memory Card; Use Radio Shack Model 100 portable with a CP/M system; Write Menu-Driven Utility for Setting Printer Options; North Star Improvement; True Z-80 Random Number Function; Hide Code in Basic REM statements; Machine Code loader for MBasic; Increase Single-Density Disk Formatting; Relocating Assembler & Linkage Editors, Part 2; Run MX-80 with North Star; User Group Directory; CP/M-86 Versus CP/M-80; REVIEWS: CP/NET, QBAX, S-Basic.

SEPTEMBER: Using RatFor; Relocating Assemblers & Linkage Editors, Part 1; Sleuth WordStar Files with Pascal; CrossCheck Program; CP/M <-> NorthStar File Transfers; NorthStar DOS as a CP/M COM File; Add Rescue Key to System; S-100 TMA Interfacing; REVIEWS: Altos 586, Com: uP 816C, Ithaca InterSystems Encore, Dual Systems 83/20 Unix System, Supersoft C, Software Tools, Morrow Designs Micronix, Upgrade Older S-100 Systems to CompuPro Dual Processor.

AUGUST: XERA Program; Logging-On CP/M; WordStar Date/Time Patch; Find Location of Variable in NorthStar Basic; Prevent System Crashes During Warm Boot; Enhance Spreadsheet Print Files; Plotting Package-Part 3; Run WordStar under TP/M; 50-line Text Formatter; Using Code loader for MBasic; Increase Single-Density Disk Formatting; Relocating Assembler & Linkage Editors, Part 2; Run MX-80 with North Star; User Group Directory; CP/M-86 Versus CP/M-80; REVIEWS: CP/NET, QBAX, S-Basic.

JULY: Using RCPMs; RCPM Directory; PIP Data Between Computers; Toward Smarter Modem Programs; Interface MX-80 via Parallel Interface; Digital Audio On CP/M System; Customize CP/M CBIOS; Plotting Package Part-2; REVIEWS: DRI PL/I-86 and PL/I-80, S-100 PMMI MM-VT1.

JUNE: Plotting Package Part 1; Drive HP Plotter; Laboratory Graphics Applications; Console Keypressed interrupts; Customize Wordprocessor Keyboard; WordStar Clone, Building Up ZCPR-3, C & Godbout Disk-1 Controller, Writing Translation Programs in C and Turbo Pascal; REVIEWS: Graffalk, JES S-100 Graphics Controller, ZCPR2.
Microsystems Back Issues continued

JANUARY: Unix Vs CP/M; Intro to Xenix; Unix on Micros; Build S-100 DMA Adaptor; Interfacing to BSR X-10 Home Control System; S-100 Troubleshooting; REVIEWS: InterSystems DPS-8000 and Coherent; Microshell, UNICA, Small-VOS, Small-Tools, Five S-100 RAM Cards, SemiDisk.

1982

NOVEMBER/DECEMBER: CP/M Vs MS/DOS; CP/M-86 Vs MS-DOS; Intro to ADA Part 2; Virtual Disk for NorthStar; CP/M Program Auto-execute; Macros & Macro-Assemblers; REVIEWS: Janus, Aztec-C, C/80, Morrow S-100 M26 Hard Disk System, Telearm S-100 Bubble Memory Card, Jade S-100 Bus Probe.

JULY/AUGUST: Hardware Random Byte Generator; Error Detection & Correction Codes; Getfile CP/M Utility Program; CP/M Patches; CP/M Application Notes; Run old NorthStar programs under new DOS; Cloning Disk Drives; Low Cost Floppy Disk Power Supply; Intro to Computer Graphics; Using Supersub Utility; REVIEWS: D80, RAID-8080, Three Macro-Assemblers, PDS, Cer-Tek S-100 Unitron Board; GrafPak.

MAY/JUNE: Intro to DBMS; Three ways to implement a mail list; Cursor Addressing; Structured Programming in Basic; Replacement for CP/M Submit; CP/M Disk Directory & Table Secrets; Mods for SDS VDB-8024; Run NorthStar Basic with CP/M; REVIEWS: DataStar, MDBS, TIM, Mince, ZDM.

1981


JULY/AUGUST: 16-Bit Disk Operating Systems; Input Queuing For NorthStar; Variable Speed Automatic Slow Step; Build S-100 Clock/Calendar Card; REVIEWS: TEC-86 System, Systemic Computer 8086 System, AlphaMicro, Godbout Dual Processor, CP/M-86, Televideo 920-C Terminal.

1980

MAR/APRIL: Linear Programming Techniques in Pascal; Intro To CP/M part 2, Addressing The Cursor; S-100 Bus - New Vs Old; Tarbell Disk Controller Mods; REVIEWS: CGS-808 S-100 Color Graphics Controller.
The following selected books can be ordered thru Micro/Systems Journal. We furnish these titles only because we feel they are very worthwhile publications.

**Interfacing to S-100/IEEE-696 Microcomputers** by Sol Libes and Mark Garetz. The definitive book on the subject. Also has great application to hardware interfacing in general.

- $17.95 (US, Can, Mex)
- $27.95 (other foreign)

**The 8086 Book** by Russell Rector and George Alexy. Probably the most comprehensive reference book on both software and hardware for the 8086 and 8088. Packed with lots of program and circuit examples.

- $19.95 (US, Can, Mex)
- $29.95 (other foreign)

**68000 Assembly Language Programming** by Gerry Kane, Doug Hawkins & Lance Leventhal. A reference and how-to book with a wealth of fully debugged programming examples. Includes assembler conventions, I/O device programming and interfacing.

- $19.95 (US, Can, Mex)
- $29.95 (other foreign)

**The Programmer's CP/M Handbook** by Andy Johnson-Laird. A comprehensive reference on CP/M's internals, file system, CCP, BDOS BIOS, etc. Examples of CP/M customizing and utilities written in C are given.

- $22.95 (US, Can, Mex)
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**The following books, by Dave Cortesi, are among the best books on CP/M and contain many programming examples. They contain a great deal of info on installation, use of command sequences, file handling, directories, etc. And comprehensive reference sections are also included.**

- **Inside CP/M**
  - $27.50 (US, Can, Mex)
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- **Inside CP/M-Plus**
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