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Artificial Intelligence



June-July 1986

No. 30

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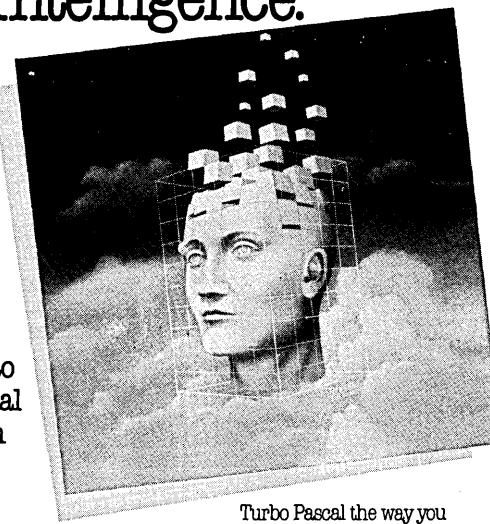
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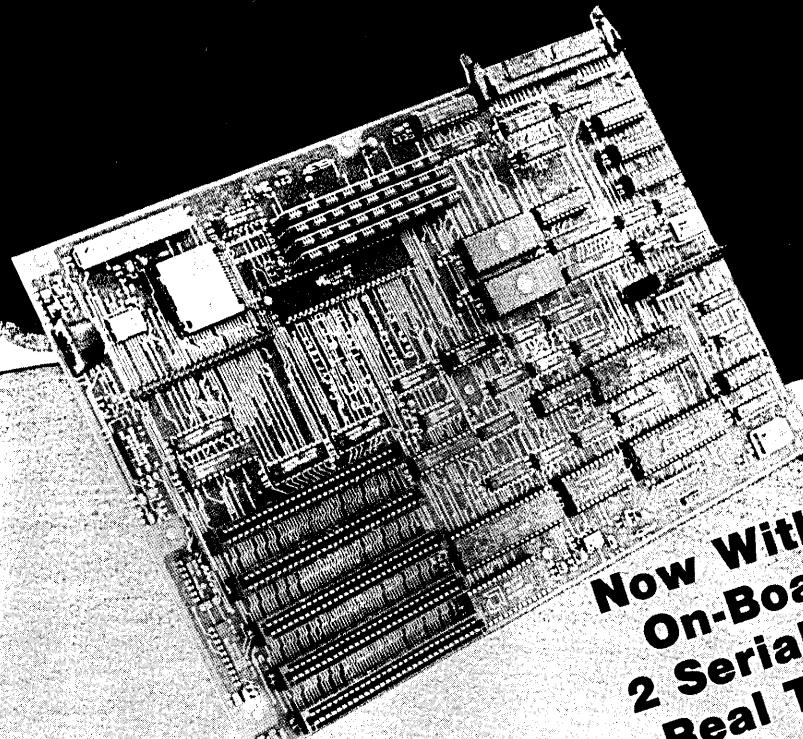
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EDITORIAL

By David Thompson

Over The Wall

Morrow Computers Says Goodby

George Morrow is still around, but Morrow computers, one of the early powers in this industry, has filed Chapter 11.

In his book *Quotations From Chairman Morrow* George wrote, "Money is the only lethal drug available on a non-prescription basis."

"We pissed away \$11 million," he commented after the filing. (Something not experienced by many.)

If someone doesn't come forth shortly with something that's green and folds and interests bankers, there won't be another chapter.

Mirror Says A Lot

Be careful when you sue someone — you might just be doing them a favor. Crosstalk is suing Softclone over its Mirror communications package for the compatibles, but publicity from the suit could be a super boost for Softclone's new product.

I called Softclone to see what the fuss was about. It turns out that Mirror will emulate Crosstalk, from communications protocol to configuration files. Mirror will also speak Christianson (CRC or checksum), Hayes, and Kermit protocols.

It has a built-in text editor, password protection, data encoding/decoding, plus it runs in the background. (Just hit both shift keys and the transfer continues in the background while you use the system for other tasks. Hit the shifts again and you're back in Mirror.)

Mirror supports practically every auto or manual dial modem (Hayes compatible and non-compatible). It will even turn a PC into a VT-100 terminal if you wish.

I ordered one. After it arrived I tried it out on everything I could find. I'd been using Mite and Modem740, but I must say, this is better, much better. One problem I found is that it holds up the sender while it's writing to disk (in 4K blocks). At 9600 baud this delay becomes significant and reduces the effective transfer rate to about 5000 baud (running on a clone and writing onto a Seagate winchester).



However, at \$49.95 (not copy protected), it's definitely the best deal in commercial modem software I've seen.

Solid

I have a Holliston XT-186 board, and it's turned out to be a quick, very dependable performer. Though it doesn't have the video speed or the built-in floppy interface of PC Tech's X-16, it certainly holds its own in the processing

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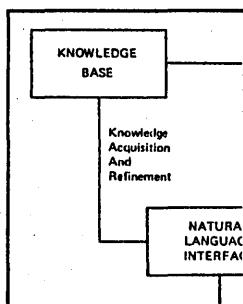
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6 PROLOG On The PC

There's already quite a collection of compilers and interpreters for this unique new language.

12 Expert Systems and Logic Programming

An overview of expert systems design using PROLOG.



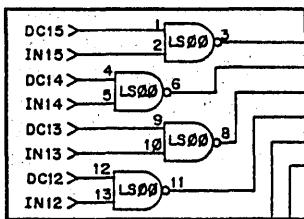
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Larry Fogg changes his clone's step rate in software. An easy, quiet mod.

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John Jones tries writing a simple draw program for the PC (and enjoys it).

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The Last Page It's recursion: again, and again, and again, and...

LETTERS

Digs The Duck

I own a DAK ADC modem and have had basically good experiences. The only problem I encountered was that one of the DIP switches did not operate correctly. But since there was an equivalent command that I could imbed in my startup file, this was not a big problem.

I also found one little "gotcha" which I suspect is not limited to the duck. The modem will run in either 300 or 1200 baud over the phone line, depending on what it detects coming in. However, I found that when I dialed a BBS which handles both baud rates, the BBS tried 300 first. The duck obediently "quacked" at the lower rate after initially connecting at 1200. The solution is simple: turn off the buffered mode (ATB0) before dialing a BBS which you know will handle 1200 baud.

Larry Blanchard
2018 N Valencia
Santa Ana CA 92706

Curing Keyboard Lockup

Several months ago a friend and I ordered speed-up mods and Pro-8 monitor ROMs from you to upgrade our 2-83s. Using the instructions enclosed with the kits we had no trouble successfully completing the modifications to both machines.

After about a half hour of continuous operation my computer developed a case of the dreaded "keyboard lock-up syndrome." After several telephone calls to Micro C, Zilog chip dealers, and MicroSphere, and quite a few suggestions that sounded good but didn't work, I got my Issue 26 of Micro C. It contained a Technical Tip about an aluminum heatsink developed by an English doctor.

Installation complete, power on, everything looked good — until an hour had passed. Then my system was off to la-la land again. I called Micro C for the third time, and that time, I got to talk to Mr. Thompson. During our 10 or 15 minutes on the phone we covered a wide range of possibilities. But when I hung up, I had a clear idea of what I needed to do.

First I checked the power supply. No problem — steady 5.045 volts.

Next I hooked up a scope to pin 6 on the CPU to see what the new 5MHz signal looked like. The waveform was quite ragged on the uphill side. In addition, the amplitude was extremely low, just over 2 volts. Just for comparison, I checked the now unused 2.5MHz pin and was amazed at the difference. The wave had an amplitude of well over 5 volts and was clean and smooth in appearance. Since I didn't have a replacement for the 74LS293 (U86 on the Micro C schematic), which provides both the 2.5MHz and the 5MHz signal, I couldn't see if it was a bad chip. Instead, I picked a 4MHz signal from pin 6 on U87 and fed it to the CPU. Eureka!

After installing a switch to allow transfer from 2.5 to 4MHz, I left the computer on for about 10 hours. No failure, and no recurrence. Thanks.

Martin Leichtung
HRC 4260 Kachemak Dr.
Homer AK 99603

Amiga Benchmarks

You asked for benchmarks on the Amiga in Issue 29; here are mine:

Benches	1	2	3
Amiga w/Int.	237.9	124.1	225.1
Amiga w/Short Int.	32.5	21.0	225.0

All times are in seconds and include floppy disk access time. I used Lattice C. The first times were done with the program as you listed it. The second times were generated with short (16-bit) integers.

Now I need some info from you: how do you protect your system in the event of a power supply failure? I just had a supply go out that cost me a motherboard and winchester, not to mention the supply. Fortunately the case and fan were just fine.

Bob Gobeille
805 Laporte Ave
Fort Collins CO 80521

Editor's note:

Lance Rutallie also submitted benchmarks almost identical to yours (he also used Lattice C V3.02). It's interesting to see the benchmark comparisons between the Amiga and the Atari ST.

A hunkering of knowledgeable guestimators came up with a set of expected times for the Amiga that showed beyond a doubt that knowledgeable guestimators don't

know what they're guestimating. They expected the Amiga to blow away anything less than an 8MHz 80286, especially for screen I/O which is measured in bench 3.

See Issue 29 for benchmark details. Times are in seconds. All used 16-bit integers (short ints for Amiga). No speed optimization was used (like register vars) when compiling.

Benches	1	2	3
Amiga w/Int.	237.9	124.1	225.1
Amiga w/Short Int.	32.5	21.0	225.0
Atari ST	28.0	18.0	35.5
6 MHz AT clone	11.2	7.4	34.2
4.77 MHz 8088	54.7	28.7	73.6
4 MHz Z80	478.2	244.6	39.0

As for power supplies, boy, you've got me. I've seen some of the cheapest switching power supplies from Taiwan put up with all kinds of electrical violence without complaint (and without damaging the system).

The old linear supplies (10-20lb 60Hz transformers and house-warming linear regulators) I have on my Big Boards weren't cheap, aren't small, and definitely aren't efficient but after almost 6 years they haven't eaten any processors.

One Out Of Two Ain't So Good

My first order to DAK was satisfactory, although it took four weeks for delivery instead of Mr. Bollinger's four days. My second order, however, was a nightmare. The printer I received was a defective, used one that had already been sent back by a dissatisfied customer in Florida. I found his address label as well as a used candy wrapper in the "factory" packing. Parts of the case were missing, and the machine never would initialize.

Two calls to customer service went unanswered. When I finally got through, their reply was, "You may send the merchandise back for a refund (sans shipping fees both ways)." A certified letter to the president of the company produced no better results.

I believe companies which make mistakes should be willing to correct them at their cost instead of making the customer pay for those errors. Needless to say, I will never do business with DAK again.

David Randles
P.O. Box 8461
Medford OR 97504

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THE CHALLENGER XT-186

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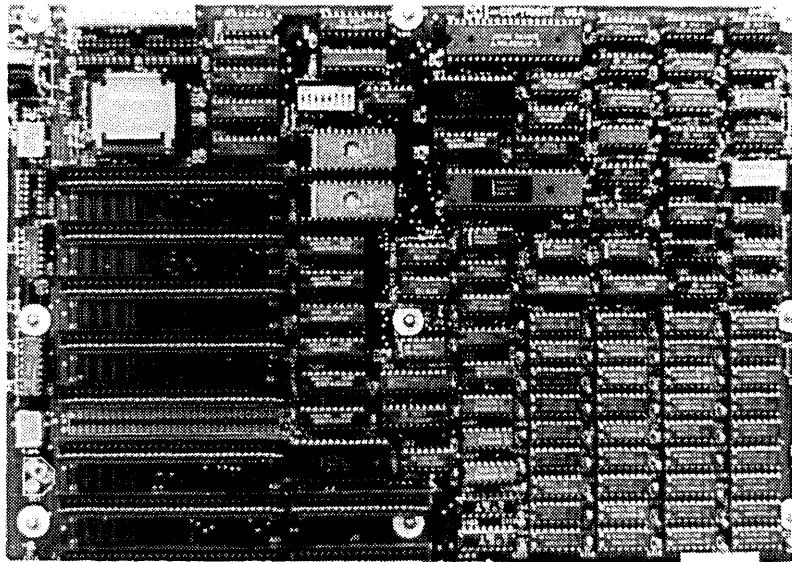
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PROLOG On The PC

By Gary Entsminger

Starting Out In PROLOG

PROLOG, what's in it for you?
What's it like to work with? Who's got the best PROLOG package for beginners writing expert systems (or experts writing beginner systems)? Gary has dug up some very interesting information about new implementations of this language.

The idea of logic programming isn't new — PROLOG (for PROgramming in LOGic) was first implemented in Marseilles in 1972 — but its popularity had to wait for the Japanese to select it for their Fifth Generation Project language in 1982.

The Fifth Generation envisions computer hardware engineered for logic processing (earlier generations of computers were engineered for arithmetic processing) and a logic programming language (i.e. PROLOG) for interacting between the logic processing hardware and the upper level software that implements problem solving strategies.

PROLOG Briefly

Essentially, a PROLOG program is a set of logical definitions about relations. Instead of specifying the flow of actions to be performed (the "how" of execution) as we do in a procedural language like Pascal or C, we describe "what" is to be executed and leave the specifics of implementation to PROLOG. See Figure 1 (benchmark tests) and the factorial program in The Last Page (this issue) for examples of PROLOG programs.

Eight fundamental syntactic concepts compose the PROLOG notation — numbers, variables, constants, lists, clauses, conjunctions, facts, and rules. A PROLOG program consists of a database of sentences (made up of clauses, etc.) that define relations.

A clause (or predicate) is the fundamental way of specifying a relationship between terms. For simplicity, you might think of a predicate as a

resemblance to a procedure or function in a conventional language like Pascal, with arguments enclosed in parentheses. For example —

```
SUCC(X Y) if  
SUM(X Y1 Y).
```

describes the successor relationship in micro-PROLOG.

For a more detailed introduction to PROLOG, see "Programming in PROLOG" by Clocksin and Mellish (published by Springer-Verlag), which

describes the Edinburgh syntax, "micro-PROLOG: Programming in Logic" by Clark and McCabe, which describes the micro-PROLOG syntax, (published by Prentice-Hall), or D.E. Cortesi's excellent article, "A Tour of PROLOG" (in Dr. Dobb's, March '85).

PROLOG On The PC

Currently, a number of PROLOG interpreters and compilers are available for the PC, ranging in price from a public domain interpreter from Ada

Figure 1a - Turbo PROLOG Program For Reversing A List Using Append

```
domains  
    integerlist = integer*  
  
predicates  
    reverse(integerlist,integerlist)  
    append(integerlist,  
          integerlist,integerlist)  
    generate(integerlist,integerlist)  
  
clauses  
  
reverse([],[]).  
reverse([X|Y],Z):-  
    reverse(Y,Y1), append(Y1,[X],Z).  
append([],X,X).  
append([X|Y],Z,[X|W]):-  
    append(Y,Z,W).  
generate(0,[ ]).  
generate(N,[N|Y]):-  
    M is N-1,  
    generate(M,Y).  
test:-  
    generate(50,X),  
    write(X),  
    reverse(X,Y),  
    write(Y).
```

Figure 1b - micro-PROLOG Program For Reversing A List w/o Tail-recursion

```
(( ) D-reverse (_X _X))  
(( _x|_y) D-reverse (_Y _Z) if  
   _y D-reverse (_Y (_x|_Z)))  
(_X reverse _Y if  
   _X D-reverse (_Y ()))
```

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In this review, I'll quickly outline the features of each of the PROLOG tools I tested and indicate which ones will (I believe) serve the beginner and the applications programmer.

In general, PROLOG tools have improved significantly during the past year, and all those tested have merit. The principal differences in the implementations are in syntax, features, speed, documentation, and ease of use. As usual, you get what you pay for, but "higher price" doesn't necessarily mean "better product." Read on.

Ada PROLOG

Ada comes in several flavors, from a beginner's public domain version (mentioned earlier) through an educational and virtual memory version to a full-featured professional implementation. The main differences between them are price and features.

For \$8 you get an Edinburgh core PROLOG without floating point, a debugging (or tracing) facility, random access to files, access to DOS commands, virtual memory, etc. But, if you're just wanting a very inexpensive taste of PROLOG, this might be the place to start. Unfortunately, the lack of so many crucial features (particularly the debugger) will probably give you a distorted view of PROLOG. If I wanted to spend as little as possible to discover what PROLOG is about, I'd spend a little more and get the .FS version.

At \$49.95, .FS PROLOG includes all the features I mentioned in the last paragraph except for virtual memory. The syntax is the Edinburgh standard, so a combination of .FS and a copy of Clocksin and Mellish will be sufficient to get you started toward sophisticated PROLOG programming.

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TOMORROW'S COMPUTING INNOVATIONS

(continued next page)

Table 1 - Benchmarks

PROLOG	Factorial Limit	Recursion Limit	Reverse List (50 members)	Reverse(Tail) (300 members)	Search (1000 members)
ADA(VMA)	12!	75	0:25	16:20	0:36
ARITY	69!	300+	0:04	0:06	0:08
Turbo PRO	171!	290	0:01	0:02	0:01
microPRO	84!	50	0:05	0:06	0:06
MPROLOG	10!	50	0:08	0:06	0:08
PROLOG2	10!	50	0:04	0:04	0:06

NOTES: All benchmarks use recursion. The recursion limit was determined by the reverse list test which is heavily stack intensive. Reverse(Tail) uses tail recursion and virtually eliminates the use of the stack. Search is a fundamental speed test: searching a 1 rule database. For comparison -- the factorial limit of Turbo Pascal using integers is 7!; 33! using reals. All benchmark results shown were executed with interpreters (except Turbo PROLOG). Times for Arity's and Expert's (PROLOG2) compilers are several times faster.

PROLOG On The PC

(continued from page 7)

The top of the line model from Ada (VMA PROLOG) at \$250 is almost full-featured — including virtual memory, tree structured domains, and access to DOS commands, which allows you to invoke your own choice of editor. Its main drawback is a lack of speed. As the benchmarks show (see Table 1), VMA is the slowest of the PROLOGs tested. So if you're going to spend more than \$50, you might look elsewhere for a PROLOG.

micro-PROLOG Professional

micro-PROLOG from Programming Logic Systems is the oddball in the PROLOG world syntactically speaking. It implements a LISP-like syntax which differs from Edinburgh's in several ways, in particular in its exclusive use of parentheses in list processing.

For example, in the Edinburgh syntax an expression containing a member and a list might look like this —

```
member(X,[X|_]).  
member(X,[_|Y]) :- member(X,Y).
```

The brackets indicate a list. Loosely translated the expression means —

X is a member of a list that has X as its head, and X is a member of a list

that has Y as its tail, if X is a member of the tail of the list.

In micro-PROLOG, we'd write —

```
X member (X|Z)  
X member (Y|Z) if X member Z
```

Notice the lack of brackets, the "if" instead of ":" , and the lack of punctuation. You might think of micro-PROLOG as a bare bones PROLOG, perhaps a little harder to read initially, but in the long run, quite powerful.

micro-PROLOG Professional is Programming Logic Systems' top of the line model. It's full-featured, including a WordStar-like editor, screen cursor control, modules, and the capability for interfacing to assembly language subroutines.

It comes with a copy of Clark and McCabe's definitive text (a good tutorial) and the SIMPLE front-end which is very user friendly.

SIMPLE is a windowed environment running above the interpreter which enables you to load files, trace and run programs, add and delete clauses, and edit files.

Once you've gotten the hang of PROLOG, you can bypass SIMPLE and its menus and interact with the interpreter directly, or if you choose you can write your own interactive

front-end (say, for an expert system). The possibilities are limited only by your imagination. APES, an expert system shell from Programming Logic Systems, is an example of such a shell.

micro-PROLOG seems to have few problems — lack of a compiler to create stand-alone programs and the oddball syntax are the main ones. Its documentation is excellent, and its speed in the benchmarks was more than adequate.

It's \$395, and for the money you get an excellent implementation — worthy of beginner or professional.

PROLOG 1 And 2

Expert Systems offers two choices of PROLOGs — an interpreter (PROLOG1) and a compiler/interpreter combination (PROLOG2). The compiler increases operating speed significantly (about 5 times), but does not compile to standalone programs. At \$1895, the compiler is out of reach for all but the professional developer.

PROLOG1, Expert's interpreter, is a good implementation of the Edinburgh syntax, including numerous built-in predicates for screen and window handling and manipulating the database via hash tables. At \$395 it's competitive with other PROLOGs, although

Table 2 - Features of PROLOG Implementations

PROLOG	VER	COST	MEM	ED	FLT	DOS	CUR	FILE	WIN	STR	MOD	INT
ADA(VMA)	1.9	\$200i	128K	a	y	y	y	y	n	y	y	n
ARITY	4.0	\$350i \$795ic	640K	a	y	y	y	y	n	y	y	y
Turbo PRO	0.5	\$99c	384K	y	y	y	y	y	y	y	y	y
microPRO	1.2	\$395i	256K	y	y	n	y	y	y	y	y	y
MPROLOG	2.1	\$495i	512K	l	n	n	n	y	n	y	y	y
PROLOG2	1.2	\$395i \$1895ic	384K	y	y	y	y	y	y	y	y	y

NOTES:

i = interpreter

c = compiler

ic = interpreter
& compiler

ED --

a = accesses your editor
from the PROLOG
interpreter

l = line editor

y = full screen editor

FLT = floating point

DOS = access to DOS from within
the interpreter (or compiler)

CUR = predicates for cursor control

FILE = random access to files

WIN = predicates for using windows

STR = predicates for string handling

MOD = modules

INT = interface to other languages
(assembler, C, Pascal)

lacking the excellent windowed, user-friendly environment (complete with online help) that comes with PROLOG2.

Like micro-PROLOG, PROLOG2 creates a work space conducive to learning PROLOG, but unfortunately, the documentation, while technically complete (running to about 500 pages) wouldn't give the beginner much comfort (if he could afford it), confirming my impression that PROLOG2 is not intended for the first time PROLOG programmer. However, PROLOG1 (the interpreter) does come with a tutorial.

Both systems are powerful, performing very well on the speed benchmarks (although the arithmetic is limited).

MPROLOG

MPROLOG is a mainframe PROLOG translated to the PC, reasonably fast, although (like PROLOG2) limited for arithmetic. Oddly, it lacks floating point and includes a line instead of full screen editor — a weak combination.

The editor is easy to use once you get the hang of it, but a lot of keystrokes are necessary in order to modify a clause in a module.

For example, given this module —

MODULE Test.

All_global.

body.

test:-

write(X).

In order to change "write(X)" to "write(Y)", you would have to focus the module and rule by entering —

f M test

then list the rule test —

list test

to determine the line number. And then enter the editor with —

edit

Then make the change like so —

10: write(Y)

end

and return to command mode. It's not a difficult process, but it is tedious.

MPROLOG's documentation is lengthy (running to 500 or so pages) and useful, but like its editor, cumbersome to use. I'd have traded most of those pages for a few concise, easy-to-locate lists of commands.

Although MPROLOG appears to be an advanced system in some ways (modules, trace facilities, assembler interface, loads of built-in predicates), it does not beckon to the beginner and lacks important features for the professional — floating point, full screen editor, cursor control, windows, and access to DOS commands.

Arity

Arity PROLOG, like Ada PROLOG, comes in a variety of flavors — an Edinburgh core interpreter (for \$95) which implements the Clocksin and Mellish syntax, a full-featured interpreter (for \$350), and an interpreter and compiler (for \$795).

The core interpreter comes with a copy of "Programming in PROLOG" by Clocksin and Mellish and is a good starting point for the beginner. If you decide later to get serious about PROLOG, you can move up to one of their professional versions.

(continued next page)

(continued from page 9)

Arity's full-featured interpreter has mostly right ideas about a programming environment. Although an editor isn't included you can access your favorite from within PROLOG. The transfer is clean and quick.

Arity's professional versions include numerous built-in predicates for handling strings and files, accessing ports, and manipulating the database. No fewer than 10 predicates allow you to access the database via indices, hash tables, and b-trees, significantly reducing search times.

Arity PROLOG is definitely a professional implementation limited primarily by a lack of screen handling predicates and a windowed programming environment. It's fast, reliable, and the combination of interpreter and compiler allows the programmer to build standalone applications without the additional expense of licensing fees.

Turbo PROLOG

Borland's approach is a dramatic departure from traditional thinking. They've chosen a compiled rather than an interpretive implementation (allowing the development of standalone programs), and they're using strict type checking.

Strictly speaking, type checking seems to oppose the freeform spirit of PROLOG in which data and rules are often entwined in a knowledge base jungle.

But type checking, as any once-bitten C programmer knows, has its merits despite the objections of PROLOG purists (I leave the philosophical discussion as an exercise to you-know-who). In particular, in PROLOG, it adds speed to program execution.

A decrease in the bookkeeping (which is required of other compiled PROLOGs) enables Turbo PROLOG to blast through data and rules in mind boggling numbers of logical inferences per second (or LIPS to the initiated). Turbo PROLOG is much faster than the other PROLOGs I tested.

In addition, its programming environment is exceptionally user friendly, with Reflex-like multi-windows and menus and an array of other features (see Table 2).

One of the strengths of a PROLOG program is its flexibility, permitting the user to modify the program at runtime (wow!). The interpretive PROLOGs append and retract data to and from the program via (of course) the interpreter. Compiled versions like Arity PROLOG include key features of the interpreter in the standalone programs.

Borland's solution again is novel. Turbo PROLOG allows you to call the editor from a running (compiled) program and modify marked areas (databases). Type checking is again a key to the implementation.

Apart from the controversial type checking issue, the only potential limitation I see for TP is its lack of a virtual memory facility, a feature of all other major PROLOGs.

Turbo PROLOG requires 384K of RAM, and although many PCs have been upgraded to 640K, the professional applications programmer might be frustrated by so little room for data (gee whiz, we used to be thrilled by the seemingly boundless space of 64K). However, databases can be expanded to disk which more or less circumvents the virtual memory problem.

The documentation is very good (perhaps excellent) and includes numerous programming examples, making it an accessible (and enjoyable) starting point for the first time PROLOG programmer and the just curious.

Although the version I tested was an early beta-test version (0.5) and suffered from a few minor bugs, Turbo PROLOG looks like it's going to be a winner, for both the beginner and professional programmer.

Wrap It Up

As usual, I don't think any review can completely express the desirability or undesirability of a product. Tastes differ. Your piques differ from mine.

In this case, each PROLOG implementation has merit, and I can't say definitively that any one is THE one.

If you're only a little curious about PROLOG, then save your nickels, dimes, quarters, and dollars, and peek into the public domain or maybe the ADA .FS version.

If you think you might be serious, but hate to spend a penny more than

necessary, than Turbo PROLOG (or Arity's low-end model) is the way to fly.

And if you know already that PROLOG indeed signals the beginning of the Fifth Generation, and you intend to write a professional expert system, produce prototypes, construct natural language interfaces, prove theorems, and who knows what else, pick in order of what you can afford — one of the heavyweights (Arity or PROLOG2), micro-PROLOG (odd but very good), or TP (the new kid in town from Borland).

In any event, if you don't check into this fascinating newfangled language, you're missing out.

Cheers.

For more info —

Arity PROLOG:
Arity Corp.
336 Baker Ave
Concord MA 01742
617-371-1243

Ada PROLOG:
Automata Design Assoc.
1570 Arran Way
Dresher PA 19025
215-646-4894

Turbo PROLOG:
Borland International
4585 Scotts Valley Dr
Scotts Valley CA 95066
408-438-8400

PROLOG1 & 2:
Expert Systems International
1150 First Ave
King of Prussia PA 19406
215-337-2300

micro-PROLOG:
Programming Logic Systems
31 Crescent Dr
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Expert Systems And Logic Programming

By Ramachandran Bharath

Mgmt, Mktg, & C.I.S. Dept.
Northern Michigan University
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What is an expert system? How is it created? Why are list processing languages like PROLOG associated with expert systems rather than more familiar procedural languages like Pascal? Here are some answers.

An expert system is a program which can function as a consultant or advisor with a level of skill and reliability comparable to that of a human expert.

Although expert systems currently replicate the skills of human experts, future systems may be developed in areas of problem solving where there are no human experts.

The aim of this article is to outline the characteristics of an expert system and discuss why logic or list processing languages are more convenient for implementing expert systems than procedural languages like C, Pascal, or FORTRAN.

In particular, we'll examine the programming language PROLOG, Japan's choice of a starting point for "Fifth Generation" or "Knowledge Information Processing Systems."

General Principles

The important facets of an expert system are —

1. Knowledge Base
2. Inference Engine
3. Explanation Subsystem
4. Natural Language Interface
5. Knowledge Acquisition And Refinement Subsystem

Knowledge Base

The Knowledge Base includes the components of the program which contain relevant knowledge for a field of expertise. It contains suitable representations of facts and heuristic rules (uncertain rules which can be relied on most, but not all, of the time).

In other words, the knowledge base

includes the informal and highly reliable (but not absolutely certain) knowledge which experts work with and the formal principles which compose the knowledge in any field.

Inference Engine

The Inference Engine uses the facts and rules in the knowledge base in conjunction with the particular circumstances of a specific situation to draw conclusions (or inferences) and give advice.

Explanation Subsystem

The Explanation Subsystem, at a user's request, explains the underlying facts and rules the expert system used to draw its conclusions. Part of this subsystem is a facility for explaining why the system asks for additional information.

Natural Language Interface

The Natural Language Interface enables the user to interact with the system in a language as close to English (or French, or German, etc.) as possible.

Knowledge Acquisition And Refinement

The Knowledge Acquisition and Refinement Subsystem allows additions to and revisions of the knowledge and rules in the knowledge base.

See Figure 1, a schematic diagram of an expert system.

Expert Or Conventional

An expert system differs primarily from a conventional program by emphasizing the knowledge base.

In the 1950s and 1960s, the search for ways of making computers into more powerful problem-solvers focused on discovering GENERAL problem solving techniques. While this approach did yield some results, for example in mathematical theorem proofs, it wasn't very successful.

Eventually, there was a shift to an approach best summarized by Dr. Feigenbaum, the designer of the DENDRAL expert system for spectrographic analysis of chemical structure (generally regarded as the first expert system).

"In the knowledge is the power," he said. Or in other words, the effectiveness of an expert depends not only on his native intelligence but also on the vast stores of knowledge he acquires in a specific field. No all-purpose technique will work in all fields.

This approach led to some useful expert systems — DENDRAL; meta-DENDRAL; MYCIN, a program for diagnosis of bacterial infections; PROSPECTOR, a program for geological forecasting; and so on. For more details on these programs see references 1 and 2.

If — Then

Marvin Minsky of MIT, a pioneer and leader in Artificial Intelligence, has written: "In a sense, today's expert systems demonstrate a marvelous fact we did not know 25 years ago: if you write down if-then rules for a lot of situations and put them together well, the resulting system can solve problems that people think are hard."

In that sense, a conventional program makes use of "knowledge" too, for any if-then statement in any language is the application of knowledge to draw a conclusion. But the distinctive feature of an expert system is that the knowledge base can be modified and the inference engine (an interpreter) can apply information from the knowledge base to the current situation.

The separation of knowledge base and inference mechanism could be achieved in a conventional language, but it's far easier to implement in languages like LISP and PROLOG.

The key feature of these two languages is the lack of a clear distinction

Figure 1 - Block Diagram For Expert System

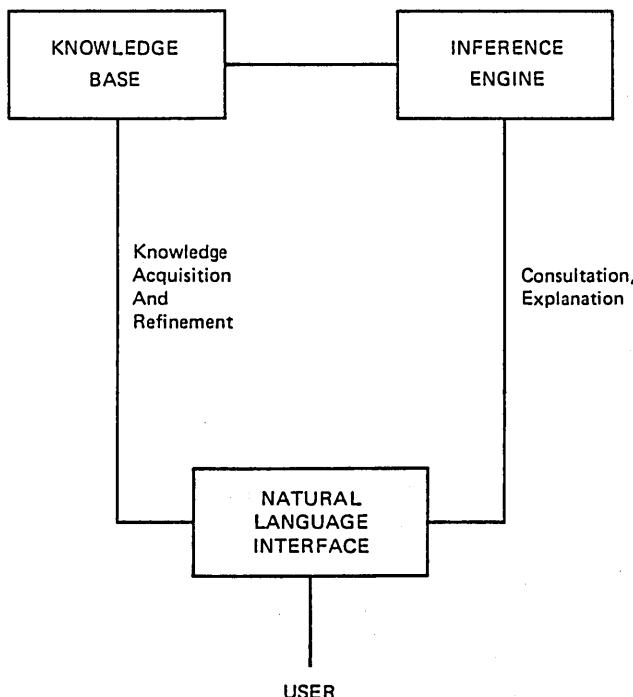


Figure 2 - Knowledge Base

```

elections(Country) :-  

economy(Country, Condition),  

Condition = booming,  

incumbent(Person, Country),  

write(' 0.6 chance of win for '),  

nl,  

write(Person),  

nl,  

!.  

elections(Country) :-  

challenger(Person, Country),  

write('challenger '),  

write(Person),  

nl,  

write('likely to win'),  

nl,  

!.  

economy(usa,booming).  

incumbent(reagan,usa).  

challenger(mondale,usa).
  
```

between "data" and "program." The knowledge base is both program and data, so the user can modify not only data but the program itself at runtime. In other words, programs modify themselves as they acquire more information, a key aspect of powerful problem solving.

Knowledge Engineering

The big problem in developing an expert system is extracting and refining the set of rules and facts from a human expert.

This task, known as "knowledge engineering," has obvious problems. For example, an expert may not be aware of all the rules and knowledge he or she uses to solve a problem.

So the knowledge engineer may have to do a great deal of sleuthing as he builds the knowledge base. And, of course, the more complex the field, the more difficult the task.

Let's consider a simple PROLOG program or "knowledge base" which makes predictions about election results using a simple rule — if the

economy is booming, predict a win for the incumbent, with a probability of 0.6. If the economy isn't booming, predict a win for the challenger.

If we put in all the information about the incumbent and the challenger, the rules (discussed above) for drawing conclusions, and express it in standard PROLOG syntax, we'd have the knowledge base shown in Figure 2.

Let's review the basic principles of PROLOG to see how this works.

A PROLOG program consists of facts and rules.

FACTS express relationships between objects. For example, the fact — `incumbent(reagan,usa)`. — relates the two objects "reagan" and "usa".

One standard PROLOG convention (the Edinburgh syntax) expresses constants in lower case and variables with an upper case letter as the first letter.

PROLOG works by matching the questions entered by the user to facts in the database. So, if a user enters —

`?-incumbent(Who,usa).`

PROLOG will match the variable "Who" to the constant "reagan" and output —

`Who = reagan.`

Similarly, the question —

`?- challenger(mondale, Where).`

would generate the response —

`Where = usa.`

based on the principles of pattern matching. The fact, `Where`, is a variable and can be matched with "usa". This kind of pattern matching is usually referred to as "satisfying a goal."

In the above examples, we set the goals —

`?- incumbent(Who,usa), and ?-challenger(mondale,Where).`

and PROLOG met them.

(continued next page)

(continued from page 13)

PROLOG Power

PROLOG gets its power from rules. For example, in one of the RULES in Figure 2 we have the segment shown in Figure 3.

If we enter the goal —

?- elections(usa).

the system will match "elections" with the left of the :- sign, and then continue to match each of the goals on the right of the :- sign in turn.

Think of the ":" as signifying "if", so in general a rule states that the goal on the left of ":" (the HEAD OF THE RULE) can be satisfied IF the goals on the right of the ":" (the BODY OF THE RULE) can be satisfied.

So to satisfy —

?-elections(usa).

the system first matches our question with the HEAD, elections(Country), and identifies the variable "Country" as "usa". Next, it proceeds to the BODY of the rule and tries to satisfy the goals one by one.

The first goal is economy(usa, Condition), and it can be matched with the fact, economy(usa,booming). The variable "Condition" is matched with "booming".

The next goal is Condition = booming, and it's now true.

Next, the system tries the goal "incumbent(Person,usa)" and identifies the variable "Person" with "reagan". Then it goes on to examine the other goals. The goals with "write" are self-explanatory, and "nl" stands for "print a new line".

To conclude this very condensed review of PROLOG, let's suppose that instead of —

economy(usa,booming).

we had —

economy(usa,shaky).

in our knowledge base. The system would be unable to "satisfy" the goal "economy(usa,booming)".

Figure 3 - Excerpt From Figure 2

```
elections(Country) :-  
economy(Country, Condition),  
Condition = booming,  
incumbent(Person, Country),  
write(' 0.6 chance of win for '),  
nl,  
write(Person),  
nl,  
!.
```

Figure 4 - Addition To Figure 2

```
(after deleting  
incumbent(reagan,usa),  
challenger(mondale,usa), and  
economy(usa,booming) ).
```

```
challenger(Name, Country) :-  
write('Who is the challenger?'),  
nl,  
read(Name),  
asserta(challenger(Name, Country)).
```

```
incumbent(Name, Country) :-  
write('Who is the incumbent?'),  
nl,  
read(Name),  
asserta(incumbent(Name, Country)).
```

```
economy(Country, Condition) :-  
write('Is current state of economy '),  
write('booming?(y or n)'),  
nl,  
read(y),  
asserta( (economy(Country, booming) :- !) ).  
economy(Country, Condition) :-  
asserta( (economy(Country, shaky) :- !) ),  
fail.
```

Figure 5 - Rule For Using Expert System

```
economy(Country, Condition) :-  
write('Is current state of economy '),  
write('booming?(y or n)'),  
nl,  
read(y),  
asserta( (economy(Country, booming) :- !) ).
```

When a goal fails, the system reverses its tracks and tries to find an alternative solution for the next goal on the left. This very important aspect of PROLOG is called BACKTRACKING.

In our example, PROLOG will go down the knowledge base trying the second rule with the same head "elections(Country)". Eventually, it will print the message "challenger mondale is likely to win".

Learning

We can jazz up the above program to make it a more helpful learning program.

(Note: the cut operator (!) is, roughly speaking, a way of telling PROLOG not to look for alternative solutions.)

Suppose we don't want to specify who the challenger is, who the incumbent is, and what the state of the economy of the usa is, as we did earlier. Instead we want the program to get this information by prompting the user.

We can arrange this new structure by deleting the facts about challenger, incumbent, and condition of the economy currently in the knowledge base and adding the new information in the listing shown in Figure 4.

Suppose we again ask —

?-elections(usa).

After the same train of analysis, we see that the system will try to satisfy the goal —

?-economy(usa,Condition).

first, but finding no fact to match will use the rule shown in Figure 5.

The goal, read(y), is satisfied if the user types "y" to confirm the economy is booming, and the system proceeds further.

Now the goal "asserta" tells the system to add the fact "economy(usa,booming)" to the knowledge base as a newly learned bit of knowledge, and the next time we ask a question about "elections(usa)", the system won't ask for information, but will match the goal "economy(usa,Condition)" with the new (added) fact.

Similarly, by analyzing the elections

rule, we can see that the first time we ask the question, the system will ask for the name of the incumbent and add this to the database.

Having satisfied all the goals, it will print the message —

0.6 chance of win for reagan

as before. But now, if we ask —

?-elections(usa).

it will proceed directly to the message, having "learned" the condition of the economy and the name of the incumbent.

And just as we can "assert" to add information to the database, we can "retract" to remove it.

Suppose we enter —

?-retract((economy(usa,booming) :- !)).

and then ask —

?-elections(usa).

The system will then ask about the condition of the economy, and if we now say "n" to indicate the economy is not booming, the system will backtrack, add the information —

economy(usa,shaky):- !

to the knowledge base, and then try the second rule for elections, asking for the challenger's name. That name is added to the database, and the message about the challenger being likely to win is output.

Wrap Up

I hope this brief introduction to expert systems has whetted your appetite for more information about the possibilities of this fascinating language.

In PROLOG, the emphasis is on describing the structure of the problem, rather than specifying the steps required in searching for a solution. You might think of a conventional language as being "imperative," i.e. giving specific commands to the computer, and PROLOG as being "assertional," i.e. describing or making assertions about the problem, leaving it to the system to work out the specific

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steps required for finding a solution.

There are slight differences in the various implementations of PROLOG; my examples have been run successfully with EDPROLOG (from Ada) and PROLOG V (from Solution Systems).

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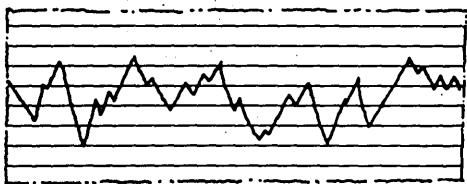
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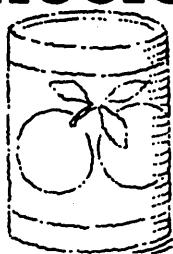
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Opening Bids In Bridge An Expert System

In the life of every new language there comes a point where it's time to stop talking and start writing. In this article, Margaret lets her code do most of her talking. It's not a bad way to learn PROLOG and expert system design.

In an accompanying article ("Expert Systems And Logic Programming") Dr. R. Bharath discusses the fundamentals of expert systems programming. In this article, I'll present a simple expert system (called BRIDGE) for determining opening bids in bridge.

BRIDGE decides an opening bid based on an input hand and a set of production rules which evaluate the holding and determine the bid. While the system can be expanded to include more of the bridge auction, I've included only the basic bidding rules.

The five essential facets of an expert system discussed by Dr. Bharath (Knowledge Base, Inference Engine, Explanation Subsystem, Natural Language Interface, and Knowledge Acquisition/Refinement System) are all present in my expert system.

I'll review each of the facets and show its code (in PROLOG). PROLOG's goal-seeking methods make it particularly suitable for this type of program.

Knowledge Base

The Knowledge Base contains the facts and rules necessary to decide a bid, the information —

1. That spades and hearts are major suits
2. That diamonds and clubs are minor suits
3. Which suits can be considered "touching"
4. Whether the hand has even distribution

5. Which is the longest suit (or suits if there are two or more equally long ones)
6. A list of all of the cards held in each suit
7. Information about the total points in the hand
8. The point count and card count of each suit
9. The bid

See Figure 1 — "Facts In The Knowledge Base."

The facts "major," "minor," and "touching" are static and can be considered definitions. All of the other facts are updatable by information input by the user.

The Knowledge Base also contains the basic rules on which the system operates (Figure 2) —

1. List processing rules
2. A rule to determine if a given hand has even distribution
3. Rules for finding the longest and next longest suits
4. Rules for evaluating the hand
5. A rule for constructing a list of cards held in the individual suits

Also included is a more complex rule for deciding the opening bid (Figure 3).

A Knowledge Base can be extensive, since it needs to hold all of the system's working knowledge. The Knowledge Base includes basic facts plus the rules which specify how those facts and how user input will be manipulated.

Inference Engine

This part of the system uses the Knowledge Base to draw inferences (or conclusions) based on a set of rules. In BRIDGE, the inference engine is simply the PROLOG interpreter.

PROLOG decides the bid by satisfying goals in the decide_bid rule (Figure 3). Decide_bid gets information

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from a player and prints out a listing of the hand and an appropriate bid.

BRIDGE uses the following rules to determine the bid —

1. If the point count is less than 13, pass.
2. If the point count is between 16 and 18 inclusive, and there's even distribution, bid 1 notrump.
3. If there are two equally long suits, bid the higher ranking of touching suits, or the lower ranking if the suits are not touching.
4. If there's a long suit (6 or more cards), bid that suit.
5. If there's a five-card major suit, bid it.
6. If there's a four-card minor suit containing an honor, bid it.
7. If there's no really biddable suit, but 3 or more clubs, bid clubs.
8. Otherwise, follow Rule 3 with the longest of not-so-long suits.

We want exactly one bid. The rules are evaluated in the order given above. If one succeeds, none of the others is attempted. The short club (Rule 7) is used when there are no biddable suits but opening hand (13 or more) points. Rule 8 is used when even a short club is impossible.

After the bid's decided, it's printed and added to the Knowledge Base as a fact.

For simplicity, the bid is always one of a suit, one notrump, or pass. Deciding an opening two or three bid would be more complex but follow similar procedures.

Explanation Subsystem

An important aspect of an expert system is its ability to explain how it arrived at a conclusion. This explanation should include information about the rules and the Knowledge Base that led to the conclusion. In BRIDGE, after the bid is decided, the player can ask — ?-why.

and receive an explanation, based on the facts and rules in the Knowledge Base and the Inference Engine. Figure 4 lists the Explanation Subsystem.

Natural Language Interface

In order to make the system available to casual users, not just to experts, the program is interactive. To begin the decision process, enter the query:

?-decide_bid.

Prompts BRIDGE to get information about the hand. The get_values rule (Figure 5) is called from decide_bid and prints the message —

Enter your hand at the prompts

It then calls on the get_suits rule four times to ask for information about each suit. (You answer 'y.' or 'n.' about honors and specify low cards with numbers followed by periods.)

To use the system, you need only know that entering "decide_bid." will start the decision making process and that entering "why." will explain the process. A more sophisticated user could, of course, call any of the other rules or query other facts in the knowledge base as well.

Knowledge Acquisition & Refinement

The Knowledge Acquisition Subsystem (I/O) is an ongoing part of the program. Information is entered and saved regarding the hand, suits, etc.

It can be argued that the bid fact is "learned," so, alternatively, a list of hands and bids could be remembered. The "learned" facts would be searched before the decide_bid options were checked. I've ignored this alternative in BRIDGE.

Figures 2 through 5 contain the information-gathering rules.

Since these rules also update the Knowledge Base, they serve the Knowledge Acquisition function as well as their primary function.



Figures 2 through 5
on pages 20 through 23.

Figure 1 - Facts In The Knowledge Base

```
/* which suits are major and minor */
major(spades).
major(hearts).
minor(diamonds).
minor(clubs).

/* which suits are touching */
touching(spades, hearts).
touching(hearts, diamonds).
touching(diamonds, clubs).
touching(clubs, spades).

/* is the hand evenly distributed */
even_distr(no).

/* Indicate the longest suit(s) */
longest(spades, 5).
longest(hearts, 5).

/* Give more detailed information
on the hand -- one fact
for each possible honor (ace,
king, queen, jack) and one fact
for the number of small cards
in a suit. */

values(clubs, small, 0).
values(clubs, y, 1).
values(clubs, n, 2).
values(clubs, n, 3).
values(clubs, n, 4).
values(diamonds, small, 1s).

/* Contains the list of cards in
the specified suit. */

hand(clubs, [jack]).
hand(diamonds, [queen,x]).
hand(hearts, [ace, jack, x, x, x]).
hand(spades, [ace, king, x, x, x]).

/* Tell the # of points and cards
in a suit. */

points(clubs, 1, 1).
points(diamonds, 2, 2).
points(hearts, 5, 5).
points(spades, 6, 5).

/* Contains the value of the hand */

hand_count(17).

/* Contains the value of the bid. */

bid([1,spades]).
```

Figure 2 - Rules In The Knowledge Base

List-Processing Rules:

```
/* Determine whether an item is
an element of a given list. */

member(X, [X | _]).
member(X, [_ ! Y]) :- member(X, Y).

/* Tells how to build one list
from two distinct lists. */

append([], X, X).
append([X|L1], L2, [X|L3]) :- append(L1, L2, L3).

/* Tells how to add a single item
to a list if the item is not
already on the list. */

add_to_list(X, Y, L) :- not(member(X, Y)), append([X], Y, L).

/* When building the list of cards
held in each suit, a small card
is represented as an "x". This
rule is used to add an "x" for
each of the small cards held.
The rule is called from the
X is C - 1, build_list rule;
C represents the
number of small cards to add. */

add_small(Suit, 0) :- !.
add_small(Suit, C) :- hand(Suit, L),
append(L, [x], Newlist),
retract(hand(Suit, L)),
asserta(hand(Suit, Newlist)),

add_small(Suit, X).

/* Note how this rule uses
recursion. The last statement,
"add_small(Suit,X)" calls itself
with the updated value of X
(each time, X is one less than
previously). Add_small is
terminated when X reaches 0.

The cut operator (!) is important
here because it prevents further
attempts to satisfy the goal
add_small (Suit, C) in the event
that C is 0. The statements retract
and asserta are used to erase old
values and insert new values into
the Knowledge Base. */

/* Even Distribution Rule: */

/* Begins by clearing out any
even_distr fact and using the
default value "no". */
```

```
balanced_hand :- retractall(even_distr(X)), asserta(even_distr(no)).

/* A hand is considered "balanced"
if there are neither very short
nor very long suits. If either
of these is encountered, the
default value "no" is kept.
Otherwise, the hand is balanced
and the "yes" value is stored. */

balanced_hand :- points(Suit, Points, Count), Count < 3, !.

balanced_hand :- points(Suit, Points, Count), Count > 5, !.

balanced_hand :- retractall(even_distr(X)), asserta(even_distr(yes)).

/* The cut operator is used again
in this rule. As soon as the system
determines that there is either a
long or a short suit, checking
stops immediately. */

/* Find the longest suit(s). */
/* Initialize the count to 0. */

find_longest_suit :- retractall(longest(Suitname, Count)), asserta(longest(None, 0)).

/* Checks each of the points facts
to determine if a count value is
larger than the currently stored
If so, that value and
its corresponding suit name replace
the previously stored values. */

find_longest_suit :- points(Suit, Points, Count), longest(Suitname, Suitcount), Count > Suitcount, value,
retract(longest(Suitname, Suitcount)), asserta(longest(Suit, Count)).

/* Looks for a second (or third)
suit having the longest count
as determined above. */

find_next_long_suit :- longest(Suitname, Suitcount), points(Suit, _, Count), not(Suit = Suitname), Count = Suitcount, asserta(longest(Suit, Count)).

/* valuating the Hand: */
/* Initializes all point and
count values to 0 for the
individual suits. */
```

```

val_hand :-  

retractall(points(Suit, Points, Count)),  

asserta(points(spades, 0, 0)),  

asserta(points(hearts, 0, 0)),  

asserta(points(diamonds, 0, 0)),  

asserta(points(clubs, 0, 0)).  

/* Calls on the get-count rule  

to evaluate each suit, and  

finally on the count_hand  

rule to evaluate the entire hand */  

val_hand :- get_count(spades).  

val_hand :- get_count(hearts).  

val_hand :- get_count(diamonds).  

val_hand :- get_count(clubs).  

val_hand :- count_hand.hand.  

/* Counting the Points and the Cards  

in the Hand: */  

/* This rule will be called on  

when evaluating the hand. It  

is called on once for each  

First, it accumulates  

into the card count for the  

individual suit the number of  

"small" cards held in that suit. */  

get_count(Suit) :-  

values(Suit, Honor, Points),  

Honor = small,  

points(Suit, P, Count), suit.  

Newcount is Count + Points,  

retract(points(Suit, P, Count)),  

asserta(points(Suit, P, Newcount)).  

/* Next it gets the point  

count for each  

honor and increments the suit count  

eachtime an honor is encountered. */  

get_count(Suit) :-  

values(Suit, Honor, Points),  

not(Honor = small),  

Honor = y, honor (Ace = 4, King = 3,  

points(Suit, P, Count), Queen = 3, Jack = 1)  

Newcount is Count + 1,  

Newpoints is Points + P,  

retract(points(Suit, P, Count)),  

asserta(points(Suit, Newpoints, Newcount)).  

/* Finally, if there are more than 4  

cards held in a suit, a point is  

added for each card in excess of 4.  

Generally, this works as well  

as the more common method of  

counting short suits and is  

preferred by some bridge experts. */  

get_count(Suit) :-  

points(Suit, Points, Count),  

Count > 4,  

Newpoints is Points + Count - 4, 4.  

retract(points(Suit, Points, Count)),  

asserta(points(Suit, Newpoints, Count)).  

/* Sets up a hand_count fact that  

counts the number of total points  

in the hand based on the suit  

points calculated in the above.  

After the hand count is tallied,  

a message is printed indicating  

the point count of the hand. */  

count_hand :-  

retractall(hand_count(X)),  

asserta(hand_count(0)).  

count_hand :-  

points(Suit, Points, Count),  

hand_count(X),  

Newpoints is X + Points, rule.  

retractall(hand_count(X)),  

asserta(hand_count(Newpoints)).  

count_hand :-  

hand_count(Points),  

print('Your hand is worth ', Points, ' points').  

/* building the Hand List: */  

/* This rule is invoked to clear  

out the suit lists before the  

suits are rebuilt based on  

current information. */  

clear_suits:- retractall(hand(Suit, Hand)).  

clear_suits:- asserta(hand(spades, [])),  

asserta(hand(hearts, [])),  

asserta(hand(diamonds, [])),  

asserta(hand(clubs, [])).  

/* This rule calls on the list-  

processing rules to build a  

list from the facts found in  

the values set. The add_small  

rule is called on to add an "x"  

for each small card.  

The add_to_list rule is called  

on to add the name of the honor  

to the list when appropriate. */  

build_hand(Suit) :-  

values(Suit, y, 2),  

hand(Suit, L),  

add_to_list(queen, L, Newlist),  

retract(hand(Suit, L)),  

asserta(hand(Suit, Newlist)).  

build_hand(Suit) :-  

values(Suit, y, 3),  

hand(Suit, L),  

add_to_list(king, L, Newlist),  

retract(hand(Suit, L)),  

asserta(hand(Suit, Newlist)).  

build_hand(Suit) :-  

values(Suit, y, 4),  

hand(Suit, L),  

add_to_list(ace, L, Newlist),  

retract(hand(Suit, L)),  

asserta(hand(Suit, Newlist)).
```

End of Listing

Figure 3 - Making the Decision: Rules for Determining the Bidding

```

decide_bid :- retractall(bid(X)).
decide_bid :-
retractall(values(Suit, Honor, Points)).

/* After the hand is entered, a
listing of the hand is printed.
The rest of the clauses decide
the bid based on the rules set up
in 1 thru 8 (See text)
Rule 1: there are fewer than 13 pts */

decide_bid :- get_values.
decide_bid :- eval_hand.
decide_bid :- clear_suits.
decide_bid :- build_hand(spades).
decide_bid :- build_hand(hearts).
decide_bid :- build_hand(diamonds).
decide_bid :- build_hand(clubs).
decide_bid :- print_hand.
decide_bid :-
hand_count(Count),
Count < 13,
print('Pass'),
asserta(bid(pass)), !.

/* Rule 2: there is even distribution
and between 16 and 18 points -
1 notrump. */

/* Rule 3: Bid the higher ranking of
touching suits
or the lower ranking if two long
suits are not touching. */

/* Rule 4: Bid the long suit. */

/* Rule 5: Bid a five-card major */

/* Rule 6: Bid a four-card minor
suit if it has an honor. */

/* Rule 7: Bid one club. */

/* Rule 8: Bid the best of suits
which are not biddable by rules
1 through 6. */

/* The use of the cut operator
at the end of each clause. It is
essential to stop the process
as soon as the proper bid is
determined. */

decide_bid :- balanced_hand.points = pass.
decide_bid :-
even_distr(yes),
hand_count(Count),
Count > 15,
Count < 19,
print('1 notrump'),
asserta(bid([1, notrump])), !.
decide_bid :- find_longest_suit.
decide_bid :- find_next_long_suit.
decide_bid :- longest(Suit, Count),
Count > 4,
longest(Suit2, Count),
not(Suit = Suit2),
touching(Suit, Suit2),
print('1 ', Suit),
asserta(bid([1, Suit])), !.
decide_bid :- longest(Suit1, Count),
Count > 4,
longest(Suit2, Count),
not(Suit1 = Suit2),
print('1 ', Suit2),
asserta(bid([1, Suit2])), !.
decide_bid :- longest(Suit, Count),
Count > 5,
print('1 ', Suit),
asserta(bid([1, Suit])), !.
decide_bid :- points(Suit, Points, Count),
Count > 4,
major(Suit), suit.
print('1 ', Suit),
asserta(bid([1, Suit])), !.
decide_bid :- points(Suit, Points, Count),
Count > 3,
minor(Suit),
values(Suit, Honor, Pts),
Honor = y,
print('1 ', Suit),
asserta(bid([1, Suit])), !.
decide_bid :- points(clubs, Points, Count),
Count > 2,
print('1 club'),
asserta(bid('1 club')), !.
decide_bid :- longest(Suit, Count),
Count > 3,
longest(Suit2, Count),
not(Suit = Suit2),
touching(Suit, Suit2),
print('1 ', Suit),
asserta(bid([1, Suit])), !.
decide_bid :- longest(Suit1, Count),
Count > 3,
longest(Suit2, Count),
not(Suit1 = Suit2),
print('1 ', Suit2),
asserta(bid([1, Suit2])), !.
decide_bid :- longest(Suit, Count),
Count > 3,
print('1 ', Suit),
asserta(bid([1, Suit])), !.

```



End of Listing

Figure 4 - The Explanation Subsystem

```

why:- print_hand.
why:- hand_count(Points),
Points < 13,
print('You have ',Points),
print(' points. This is not enough to open'), !.
why:- bid([1,notrump]),
hand_count(Points),
print('Your hand is worth ',Points, ' points'),
print('You have balanced distribution 16&18 pts'),
print('In this situation you bid 1 notrump'), !.
why:- bid([1,X]),
points(X, Points, Count),
longest(Suitname1, Count),
longest(Suitname2, Count),
not(Suitname1 = Suitname2),
print('You have 13 or more points'),
print('You have 2 suits each with ',Count,' cards.'),
print('Bid the higher ranker of two touching suits'),
print('or the lower if the suits don't touch'), !.
why:- bid('1 club'),
print('You do not have a biddable major suit'),
print('Your diamond suit does not contain an honor'),
print('Your club suit isn't biddable, but you must open'),
print('This is a short club situation'), !.
why:- bid([1,X]), points(X, Points, Count),
print('You have ', Points, 'pts and ', Count, 'Cards in ',X),
print('Bid your longest suit').
print_hand:- print('Your hand is:').
print_hand:- hand(Suit, List),
print(Suit, ':'),
tab(5),
print(List),nl.

/* why" calls on the print_hand rule first to give a complete
listing of the hand as contained in the knowledge base. It
then checks for a hand worth fewer than 13 points. If this is
the case, the message printed is that there are not enough
points to open. If there are more than 13 points in the hand,
then the bid fact (created by the decide_bid rule) is checked
to see what the bid was, and other pertinent facts in the
knowledge base are checked to help with the explanation. */

```

Figure 5 - The Natural Language Interface

```

get_values :-
print('Enter your hand at the prompts'),
get_suits(spades),
get_suits(hearts),
get_suits(diamonds),
get_suits(clubs).

/* get_values is called from decide_bid. It prints a prompt,
then calls the get_suits rule for each suit. */

get_suits(Suit) :-
print(Suit),
print('Ace - y/n'),
read(Ace),
asserta(values(Suit, Ace, 4)),
print('King - y/n'),
read(King),
asserta(values(Suit, King, 3)),
print('Queen - y/n'),
read(Queen),
asserta(values(Suit, Queen, 2)),
print('Jack - y/n'),
read(Jack),
asserta(values(Suit, Jack, 1)),
print('How many small ', Suit, ' are in your hand? '),
read(Small),
asserta(values(Suit, small, Small)).

/* get_suits(Suit) will build the set of values facts as well
as get information from the user. It consists of a series of
prompts, each requiring a yes/no answer (or a number in the
case of "How many small..."). When the answer is received, a
values fact is retained recording this information. These
facts are then used as input to the rules which build the
suits, calculate the hand value, etc. These rules help decide
the bid and later explain how the bid was determined. */

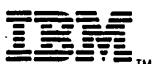
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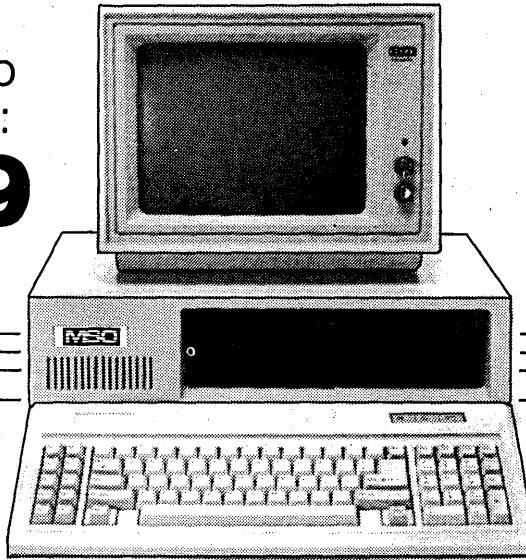
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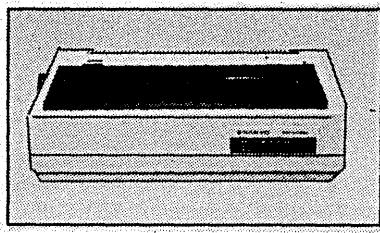
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Building Your Own Inexpensive Logic Analyzer

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Logic analyzers are expensive, mysterious gadgets that experts use to find subtle problems in inscrutable systems. At least that's been the case until now.

This is the first of two articles on building your own logic analyzer. Once you've used one of these gadgets you'll wonder how anyone debugs software (and hardware) without one. Of course, at their usual prices of \$5,000 to \$25,000 there hasn't been too much demand from individuals. With this series, all that changes. There are no more excuses for not knowing what's happening inside a system.

It's late, and you've just completed the prototype of your automatic canary feeder-burper, the best microprocessor real time controller designed for that purpose. You key in the code, flip the on switch, and are greeted by — nothing; it just sits there.

Or you've just finished writing a wonderful 20,000 line, single module assembly language program to automate the manufacture of gopher corsets. Following the procedure taught you by "tune-for-greatest-smoke" Kelly back in school, you assemble and then run the program only to be treated to the sound of several myopic gypsies singing "Marching to Albuquerque" on the assembly line stepper motors.

What Do You Do?

You could reach for the trusty scope, but you'd have a tough time trying to solve these problems. The scope has its uses, but it suffers from two major faults when working on bus-structured equipment: it has a limited number of display channels (usually 1 to 4), and it must have a recurrent (periodic) waveform to be of much help.

You'd need 30 or more display chan-

nels to watch what the newer processors were doing. Plus, scopes have a difficult time displaying aperiodic (one time) signals.

Since microprocessors are driven by software (much as programmers are driven to drink by it), it would help to capture the program off the busses, and determine the exact path taken, or not taken, by the program.

The magical device that allows us to watch a computer or any other bus structured equipment in action is called a logic analyzer, and it has been with us in different forms and price ranges for a couple of decades.

This article will describe the component parts of an ideal logic analyzer and propose a working design that can be used with the PC family of computers, at a parts cost of under one hundred dollars.

The Logic Analyzer & The Scope

Both the logic analyzer and the scope view a signal vs. time. The scope displays an analog signal (any level allowed) continuously in time.

The logic analyzer is a digital (TTL or CMOS) level device which samples and stores the logic state of an input at specific time intervals (usually determined by a system clock along with several clock qualifiers) for later display and use.

Therefore, a scope is like your eyes, viewing surroundings all the time, while the logic analyzer is more akin to a camera, preserving and displaying an instant in time.

While the scope is normally triggered on a certain slope and level of an incoming signal, the logic analyzer compares the logic state present on its incoming channels with a set of trigger states set up by the operator. When the two match, the analyzer starts or stops acquiring data.

Other bells and whistles can be added to enhance the basic system capabilities as described below.

In summary — the scope is an analog, periodic waveform display instrument while the logic analyzer is a clocked, digital, aperiodic sampler.

Block Diagram Description

The first requirement of a logic analyzer is input lines, lots of input lines.

For example, if you're working on a Z80 system, such as the Big Board family, you'll need inputs for 16 address lines and 8 data lines for a total of 24 input channels.

If you're using 16-bit microprocessors, you'll need up to 24 address lines and 16 data lines, for a total of 40 input channels.

Some type of buffering will be required to isolate and reduce loading of the system under test. To reduce the logic board density and the system under test bus loading, we'll put the input signal isolation buffers in the probe.

It's usually a good idea to stick to powers of two for anything that must be filtered through TTL logic. So we'll choose 32 input lines, a workable compromise between maximum number of signal lines that are a power of two.

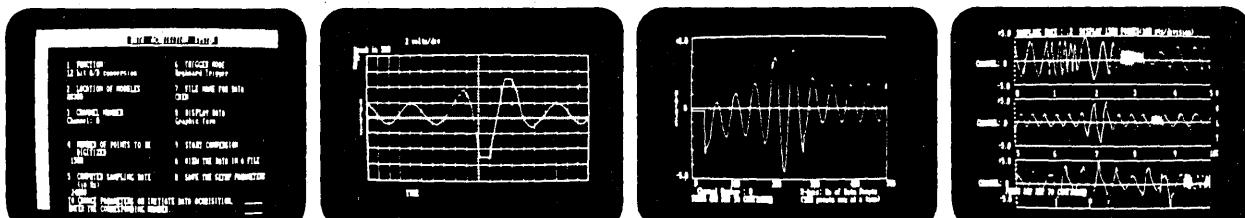
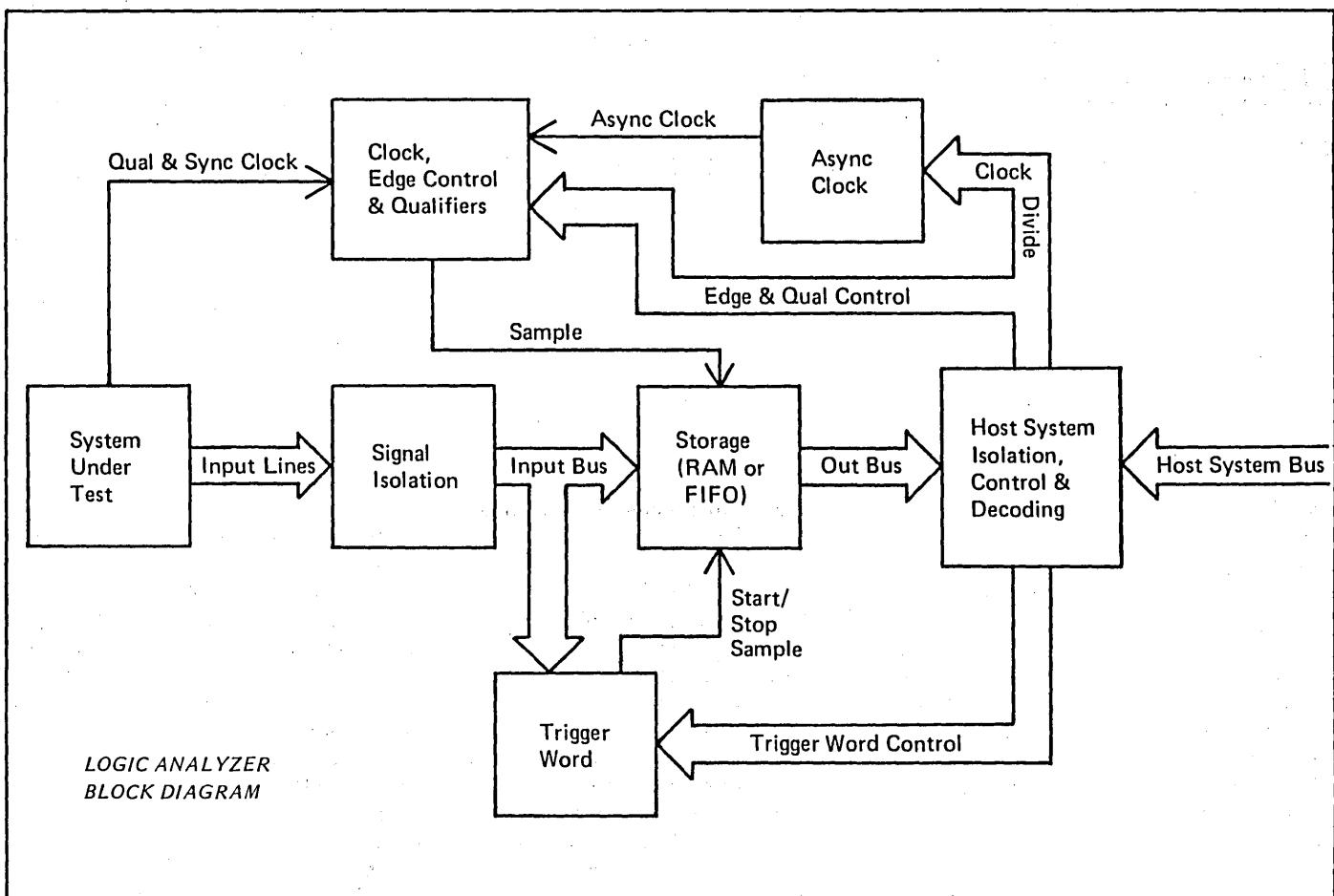
A number of the input signal lines should be available for comparison with a trigger word to start or stop the sampling process.

If, for example, you know the system is running correctly until address 00FOH, that would be the initial trigger word set for the address line inputs. After viewing the block of data acquired starting at this address, a higher address can be specified to obtain the next block of data.

High, Low, Don't Care

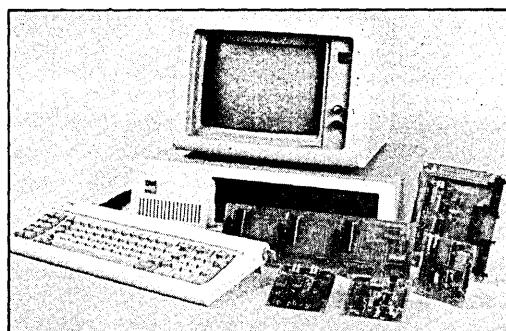
Three states are required for signal comparison: high, low, and don't care (input can be either high or low). When approaching a new prototype

(continued on page 28)



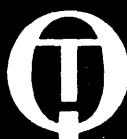
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(continued from page 26)

(with due caution, they bite), you would normally set the qualifiers to "don't cares" just to get some idea of what's on the busses.

The number of samples that can be obtained in one run is determined by the logic analyzer storage capacity. So information about the system bus activity is obtained in chunks, each of which guide you closer to the problem.

In some logic analyzers, the trigger word can be at the beginning or ending of an acquired block of data. Triggering at the end of the data block allows you to view data before an event, such as before an endless loop. To try to keep the parts count within reason, we'll define 16 of our 32 input lines as trigger inputs.

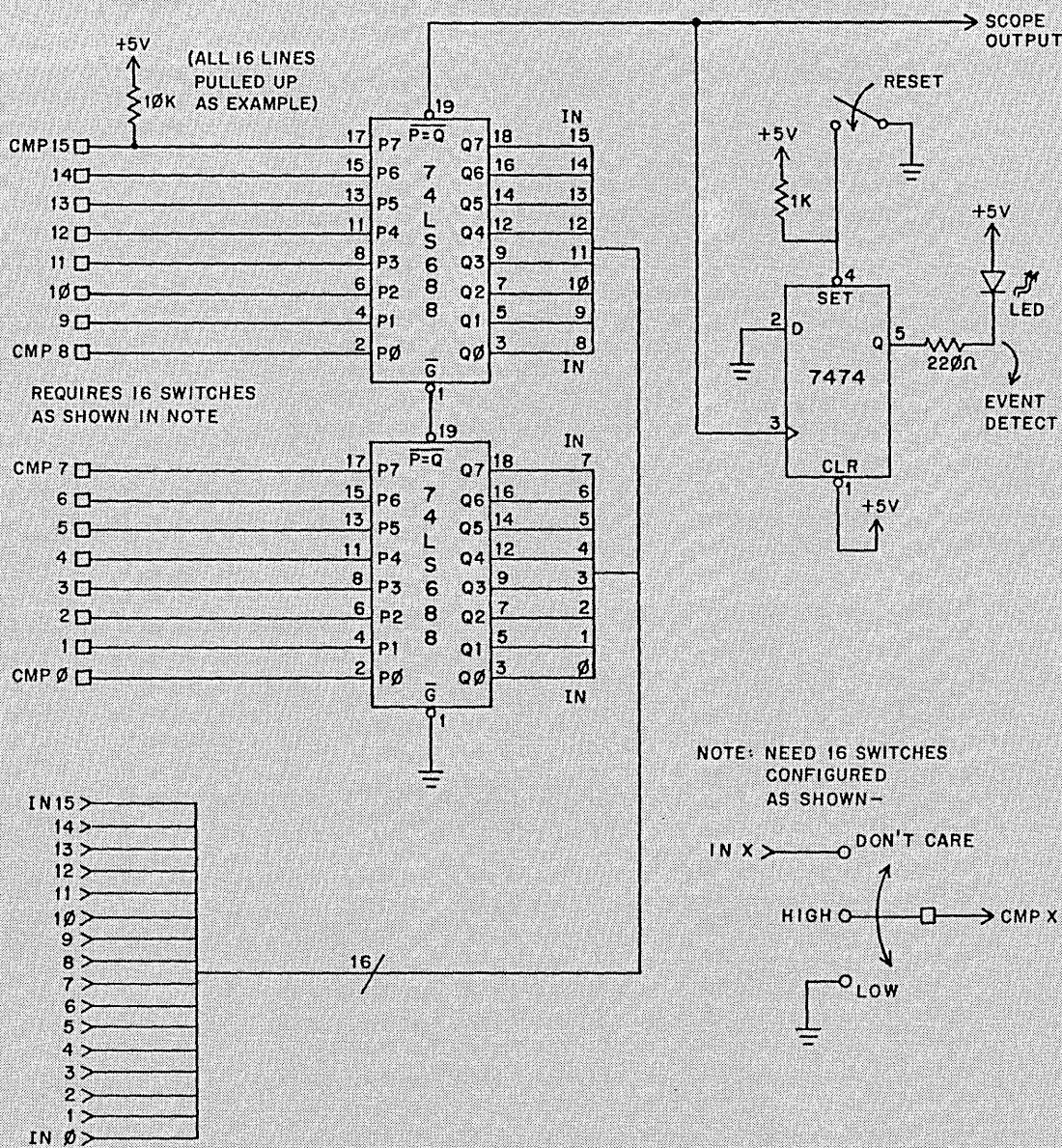
An LED Circuit

See Figure 1 for a simple circuit that allows you to compare a 16-bit trigger

word with 16 signal inputs.

The LED circuit output shows if the chosen trigger word appeared on the system bus, while the scope output allows you to externally trigger a scope on the output and thus monitor the signal lines referenced to this point. Remember, the scope won't work unless you can create a periodic (repeating) signal. If you don't have any 74LS688s in your junk box (pardon me, your surplus parts storage repository), you can use 7485s instead.

Figure 1 - Bus Capture



The clock output from the system under test, the heart of the logic analyzer, should be edge programmable allowing sampling of data on either the rising or falling edge.

Also needed are several qualifiers that allow a clock transition only under specific conditions, such as read status, write status, I/O status, and so forth.

For example, if you're interested in microprocessor read activity, you would attach an active low clock qualifi-

er to the -RD line. This is ANDed with the system clock, and allows a clock transition only when the proper clock edge is present and the read input is low.

Several clock qualifiers are necessary to allow maximum flexibility. Since the 7485 allows comparison of four lines, we'll use four qualifiers in our system.

Asynchronous Selectable Period Clock

An additional "nice to have" option would be an asynchronous, selectable

period clock which would let us simulate a scope while troubleshooting circuits that don't have a master clock, but still require viewing of many input lines. How would you like to generate an entire logic board timing diagram (32 lines) at once? What power!

When using the asynchronous clock, the qualifiers would be disabled since the object now is to obtain a timing diagram which requires accurate time sampling and measurement.

Since the asynchronous clock can be simply generated by using the synchronous clock input and a periodic pulse generator such as an LM555, we'll reserve this feature as an option.

Being able to delay after trigger a set number of clock cycles helps speed up the sampling process because the trigger word can be set to a standard value and only the clock delay changed.

If you can store 256 samples starting from a given trigger word, you can start with a clock delay of 0 for the first block, a delay of 256 for the second block, 512 for the third and so on.

Of course, you could change the trigger word for each block, but it's often difficult to pick a unique trigger for every point.

A clock delay feature allows the choice of a single unique trigger word, with blocks offset from that unique point. This feature is much like the delayed sweep on a scope. Since this feature is another "nice to have," we'll enter it as a desirable option.

Storage (For Glitches)

Next you'll need some type of storage for all this nice information you're gathering. There are two choices: fast RAM (50ns or less), or FIFOs (first in, first out) which are fancy shift registers.

FIFOs are easier to use, but expensive and difficult to find. RAM also has more capacity so you can store larger blocks of data. Again, trying to strike a reasonable balance between system cost, circuit complexity, parts density, and availability, let's use RAM.

A glitch is defined as a signal that goes up and down between samples.

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Document package (incl. with system)		8.00
Enclosure 5.25" FH, with P/S - 69.00		without P/S - 49.00



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(continued next page)

(continued from page 29)

Glitches are caused by noise spikes in digital circuits, power supply noise, asynchronous counters, phase of the moon, circuit bypassing, operator attitude, and bosses' temper tantrums.

A nice memory option is to provide storage and pulse stretchers to capture the not-so-rare beasts. Unfortunately, glitch detection requires virtual duplication of most of the logic analyzer, so, as nice as this option is, we won't include it.

PC Interface

All that's left in the specification of our system is the host computer (the PC/XT) interface. Here we'll need some input ports to get the data from logic analyzer storage to PC storage, some output ports for everything we're controlling, and decoding to turn it all on and off at the proper time.

Also we'll need a software driver to take the raw acquired data and put it in readable form (HEX display, timing diagram, disassembled code, etc.) and a way to transfer control information between the XT and the logic board.

To recap, our ideal logic analyzer will have:

- 32 input lines
- 16-bit wide trigger word
- 60ns sample time
- 4 qualifiers (for the clock)
- clock edge select

Circuit By Circuit

The system under test is isolated by the four 74LS244 buffers placed in the probe module.

The WINDOW output, when high, tri-states the buffers isolating the system under test from the logic analyzer, such as during transfer of the acquired data from the logic analyzer to its host.

When low, the buffers are enabled to allow data flow from the system under test into the logic analyzer. Isolating these four buffers in a separate probe reduces capacitive loading of the circuit under test while also decreasing the logic analyzer circuit board density.

The four qualifiers and the clock are not buffered as they are terminated

into a single 74LS input which a buffer wouldn't improve. If you're using long lengths of input cable (longer than 3 feet), add another buffer to the probe for the qualifiers and the clock.

If you want to be really safe (a belt and suspenders man), separate the clock from the rest of the signal lines and run it through a coax cable. I've had good luck, however, with unbuffered, unseparated qualifiers and clock inputs. I ran all inputs through a 50 ohm line, 36 inch length of ribbon cable, isolating the clock by bracketing it with grounds (the wires on each side were connected to ground).

Trigger Word

The lower 16 of the 32 input lines are used to set a trigger word which marks the starting location in the data stream. The three legal conditions for the trigger word are set by the 74LS00 Nand gates and the 74LS688 Octal Comparators.

To handle the high or low states, the data input line from the probe buffers, (IN0 -> IN15) is passed (and inverted) by setting its matching data compare line (DC0 -> DC15) high.

These two lines are NANDed together, and the output is passed to the Octal Comparators, which compares it to the system compare (CMP0 -> CMP15) lines. Since the input lines are inverted by the Nand gates, the respective CMP line must be the inverse of the desired trigger state.

The don't-care condition is handled by setting the data compare line low which blocks the input line and sets the Nand gate output high. The system compare line is then set high to match this state. More input lines could be added to the trigger word by adding additional Nand gates and Octal Comparators.

The final output of the chain of comparators is used to latch a high logic analyzer clock enable into the 74LS112 JK Flip Flop which is used to enable the 74LS85 Quad Comparator which handles clock qualification.

When the DONE output from the Address counters goes high (signaling the start of a sampling session), the clock input to the logic analyzer is passed through the first And gate. The second And gate passes it if the four qualifiers match their programmed

states (QUAL0 -> QUAL3), and if the trigger word has enabled the qualifier comparator (the 74LS85). When DONE goes low, the clock stops and the host system, which has been polling the DONE state, takes control.

Clock

Clock edge inversion is provided by an Exclusive Or gate which is used as a programmable inverter. When the EDGE output is high, the clock is inverted; when low, it isn't.

Since data is strobed into storage on the rising edge of the clock, EDGE low would be rising edge transfer, EDGE high would be falling edge transfer. The ADDR INC output allows the host system to control the address line counters when transferring data.

Under remote operation (system under test controlling the clock) the ADDR INC output is set. When the host system takes control, EDGE is set thus driving -WR high, and ADDR INC is pulsed to increment the address inputs to the RAM.

The sanitized, qualified, and purified clock (-WR output) strobes the input data (IN0 -> IN31) into the 2148 RAM array on its rising edge. The same edge is used to increment the 74LS393 address counters, which changes the address about 40 nanoseconds later, setting the address for the next data strobe.

When the RAM is full, A10 goes high, pulling DONE low as outlined above. The access time of the RAM used will determine how fast you can acquire data. Generally, slow means cheap, fast means expensive, so get the fastest you can afford.

Host Interface

The host system interface is provided by the address decode circuitry which includes the 74LS04 inverters, 74LS30 8-input Nand gate, and the two 74LS138 decoders. The decoder controlled by the I/O Write input is used for the five 74LS374 output ports and the -RESET line. The I/O Read controlled decoder is used for the five 74LS244 input ports. The Base address for both decoders is 320 Hex which fits in the prototype card locations specified by IBM. If you require a different address space, change the inputs to the 74LS30.

With some effort, the logic analyzer could be used by any host such as the Big Board, Xerox, and Kaypro that has access to a bidirectional data port for D0 -> D7, one enable output replacing the 74LS04s and the 74LS30 (connected to the pin 4 on both 74LS138s), and two outputs for the I/O Read and Write (or one output and an inverter).

Software

The software can be as simple or as complex as you wish. In sequence it must:

1. Set the trigger word, qualifiers, and clock edge to the desired configuration.
2. Set ADDR INC high and WINDOW low.
3. Reset the address counters and the trigger word latch by addressing the reset location (325 Hex).
4. When DONE is low, set WINDOW and EDGE high.
5. Since DONE is low, the address lines to the RAM are set to zero. Load the 32 bits of data through the 4 input ports.
6. Toggle ADDR INC, then load the next 32 bits of data.
7. Repeat 7 until all data is transferred (RAM holds 1024 long words — 32 bits each).
8. Massage and display the acquired data to your liking.
9. Go back to 1, or exit the system.

Bells And Whistles

Extras not used in this logic analyzer along with possible ways to include them are:

1. Clock delay — could be added by including a counter in the clock channel and the necessary output lines to program the count delay.
2. Qualifier don't cares — add 4 Nand gates and 4 output lines.
3. Stop on trigger word — include extra logic between the trigger word output and the DONE output.
4. Asynchronous clock — add the counters, clock, output divide control lines, and the logic to switch between the synchronous and asynchronous clocks.
5. Glitch detection — add another logic analyzer. You'll need separate RAM, ports to handle it, and the necessary pulse stretching for each input.

I didn't add these options because the parts and cost count were high enough. If you need them, use the base circuit and add to it.

Culmination

Since my wife insisted on my doing such non-essential tasks as sleeping and eating, the software will be delayed until the next issue. This gives you time to build the system, and me time to find a new hiding place.

If you must have the nasty stuff

before then, and you have a modem, call (314) 443-7294, ask for Don, and give the coded passage: "I must have my software fix!", and I'll transfer what I have (300 or 1200 baud).

I'm also selling a version of the logic analyzer (see ad in this issue), or boards and parts as a service for Micro C subscribers. Contact me for prices.

See you at SOG V

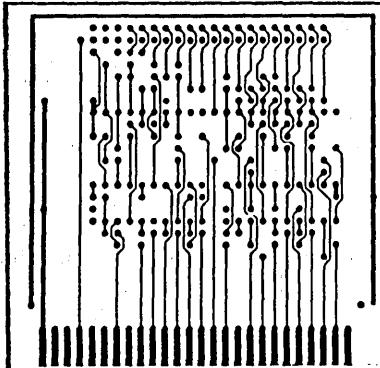
(Editor's note: Don will be speaking at SOG V and he might even have some logic analyzer software with him...).

Note: Schematic on pages 32 and 33.



PCB EDIT

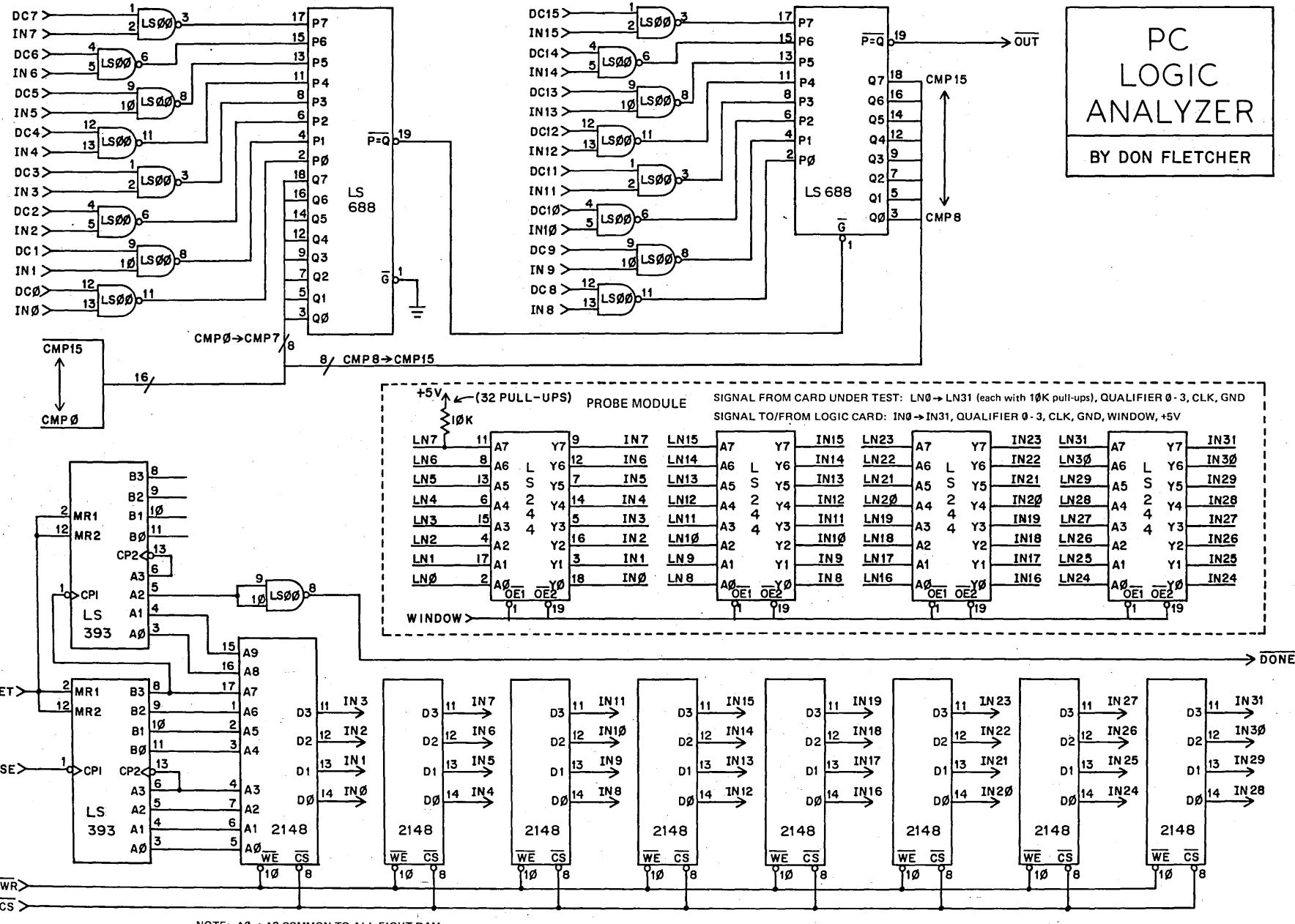
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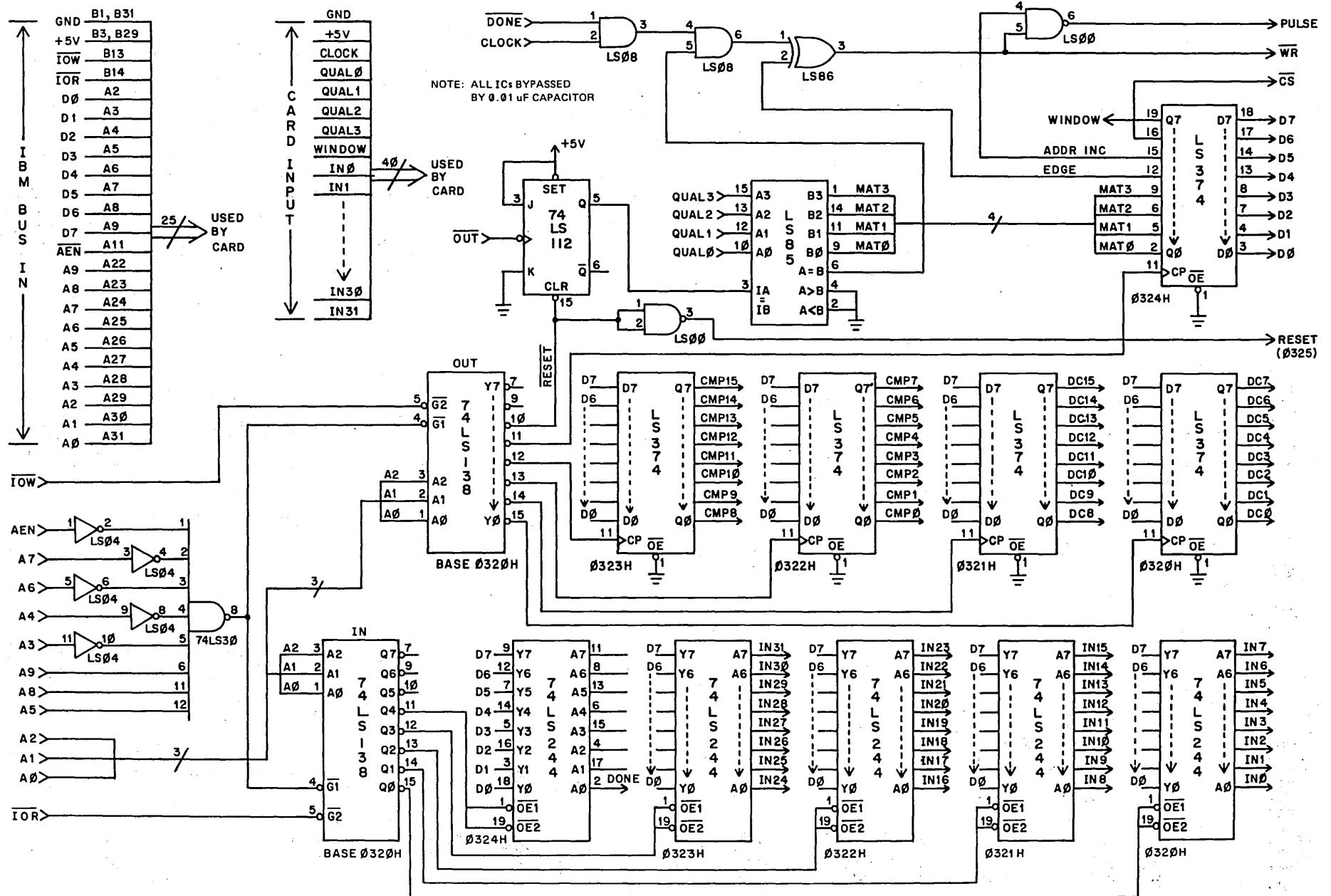


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White TTL Monitor (hi-res monochrome)	\$130
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2 layer boards have traces on the top and bottom of the circuit board. 4 layer boards have two extra layers of traces sandwiched between the top and bottom of the board. When comparing a 2 layer board against a 4 layer board of the same size, the 2 layer board will have longer trace runs (which increases the resistance to the signals traveling through the traces) and the traces will be closer together (which increases the possibilities of interference from a neighboring trace). The faster the signals travel through the traces, the more exaggerated these problems become. For those who want to run an XT-type motherboard at 8mh, we recommend a 4 layer board.

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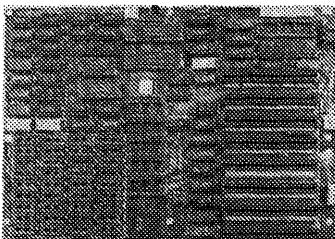
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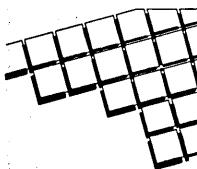
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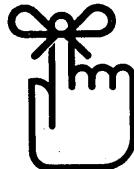
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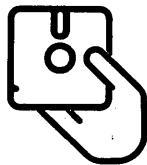
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Importing Systems From Taiwan, Part II

By Laine Stump

Development Foundation of Turkey
Tunali Hilmi Cad. 22
Ankara Turkey

If you enjoyed the article on doing your own importing in Issue 29 then you must read about Laine's travels through eastern Asia searching for new bargains and legitimate suppliers. This is the journey we'd all like to make.

So you want some justification for the "World" in 86 World, huh?

As I'm writing this sentence, our flight is just leveling off after takeoff from Hong Kong International Airport (I'm writing with my brand new toy, a Toshiba 1100 portable). We arrived in Hong Kong yesterday afternoon after spending a week in Tokyo attending Comdex-Japan and two weeks in Taipei talking to scores of computer suppliers and manufacturers and others who professed to be one or the other (or both) but were neither. But first some background...

Why East Asia?

The company I'm working for has its main office in Ankara and approximately 30 field offices scattered all across Turkey. One of my jobs is to set up microcomputer systems to be used for accounting at the field offices. (We will eventually have at least 100 PCs, several network file servers, printers, and possibly other equipment.) Because of the sinful price and poor-to-nonexistent service offered by the local distributors of American and European equipment, we decided to go direct.

We had considered using Slicers with CCP/M and several terminals, but decided that a network of PCs would provide easier hardware expansion capabilities in the future, and using MS-DOS would give us a greater software base.

Since the cheapest PCs come from the Far East (Taiwan in particular), we counted that as our best bet, but figured we should check it out first

just to make sure of what we were getting ourselves into.

Info And Samples

Last October I began compiling a list of names and addresses of Far East suppliers of PCs. We picked the 15 best prospects, sent them each a telex, and eventually ordered five samples — three complete units and two motherboards. Then we waited. (We're not lavished with 48-hour service like you sultans in the U.S.)

You're Selling WHAT?!!?

In the meantime, we were still receiving product information from Taiwan:

Please note that we are supplying cards which are copyrighted by some American companies. We are selling these cards at much lower prices but we shall not hold any responsibility in the event of claims by the original makers at your side. Please refer to "ADAPTORS WITH COPYRIGHT INFRINGEMENT" for pricing.

Some of the items available (for \$10/pc without manual) are:

CCP/M 3.1, 3.2, 4.1; MS-DOS 2.0, 2.11, 3.0, 3.1; Sidekick; Turbo Pascal 1.0, 2.0, 3.0; Lotus 1-2-3; Auto-CAD 2.17B; Microsoft COBOL; Microsoft FORTRAN; Microsoft C; etc.

So they have a few things to learn about copyright laws. We can still surely find SOMEONE to supply us reliably, legally, and promptly. Can't we?

Meanwhile The Hardware Shows Up

We finally got the machines and started playing. They definitely had problems.

We could tell even from our small sampling that quality control differed greatly from one company to the next. We could also tell that some companies were much more experienced in dealing with foreigners (and in dealing with computers). One company couldn't even figure out how to ship

air freight from Taipei to Ankara; we had to send them a telex with instructions!

From this experience we knew that the only way to find a good supplier (quality, reliability, and legality) was to go there ourselves and see the companies in person.

The First Leg

When Ergun (coworker) and I arrived in Islamabad from Ankara, we discovered the flight to Peking wasn't until the next morning. So we got to spend the night sitting around a table in the restaurant at the airport talking to two Chinese meat cutters (horse meat, actually) who had been visiting relatives in Turkey. It turned out that their family had come from Turkestan in Western China, but several of them had fled to Turkey during the communist takeover. Now, after 30 years, they had been allowed to travel to Turkey for a reunion.

Where Is Your Visa?

Islamabad is near the western end of the Himalayas so as soon as we took off we began circling to get up to 30,000 feet before we headed toward the "foothills." At first I was amazed by the size of the mountains and glaciers and the thousands of square miles of terrain they covered, but after about an hour of mountain after mountain, I fell asleep.

We landed at the Peking (Beijing) airport for a one hour fueling stop and as soon as the "snorkel" was hooked up and the door was open, the cabin filled with young soldiers asking to look at everyone's passports. One of them looked at Ergun's, and gave it back, then took mine, looked through all the pages, looked through again, called over one of his friends and they both looked at every page. Then they asked, "Where is your transit visa?"

"What? I didn't know I needed one."

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"Americans need a transit visa for traveling through China."

I was led down the hall into a series of rooms by a polite young man who kept smiling and saying, "You just get a visa now, no problem." I wasn't smiling; my mind was racing with thoughts of bamboo under my fingernails and meals of dried bean curd and fried locust eggs.

It ended up only costing me \$14, and I didn't even have to sign a confession of my guilt in the capitalist oppression of the world. After we took off again, one of the stewardesses told me that a few years before, a family of four Americans had been fined \$4000 for exactly the same thing. I guess the People's Republic is getting soft in its old age...

Once Is Not Enough

Before we left Ankara, I had asked one of the secretaries at the office to check every country we were going to to see if I needed any visas. She came to my office later and said, "I checked and you don't need ANY visas for ANYwhere!" So, she had made one mistake — maybe it was just an oversight (and maybe boiled chicken feet really IS a good appetizer...)

In Tokyo my friend passed through immigration with no problem. Piece of cake, I thought to myself. I strutted up to the counter and handed my passport to the man behind the glass. He looked through all the pages. Then he looked through all the pages again. Finally came the question: "Where is your Japanese visa?"

My stomach sunk. "I didn't know I needed one." Same old story. "What must I do now?"

"Probably you must leave the country and get a visa, then come back again."

After some talking and giving names for references, hotel reservations, brochures of Comdex, and all that, finally I was granted special permission to

stay in Japan for two weeks. "But next time you get a Japanese visa before you come to Japan. And fly Japanese Air Lines."

Tokyo And Comdex-Japan

Tokyo was quite a change from the Ankara scene I have become accustomed to in the last six months. Huge fluorescent light shows on all the buildings, clean streets, clean (relatively speaking) air, Mc Donald's all over town, a wonderful modern subway system, and drivers that actually stop for pedestrians.

We spent three days at Comdex. (Insidious, these Japanese.) In general we were slightly disappointed with the quantity and selection of items on display, but there were a few products that made the trip worthwhile.

Citizen Lap-Tops

One thing I was hoping to see a lot of was lap-top portables (actually I was looking to buy one to use for the rest of the trip). But the only company that had a REAL portable on display (under 10 lbs., quad density 3.5" drive, no bigger than a small box of corn flakes) told me they couldn't sell it

unless I wanted to order 10,000 or so.

This company was Citizen (of watch making fame). They had two models at their booth, one looking amazingly like the Kaypro 2000 and another with a larger screen and two front loading, super-thin floppy drives. The one that looked like the 2000 actually WAS a 2000. It turns out that Citizen makes the entire 2000 unit for Kaypro, excluding the motherboard, for \$300 a copy.

Little Flopsies

The products I found most interesting at Comdex were the 3.5" disk drives. All the drive companies were pushing these little buggers. Three inch drives have been available in the past, but only with capacities up to 1 megabyte. Well, Virginia, now you can store the entire data file for a high resolution color graphic image of Santa Claus (and all his reindeer) (in several attractive poses) on a single 3.5" floppy. Almost everybody at Comdex had models that would store 1.6 Megs (unformatted), and Teac even had a prototype for a model that would do 2 Megs!

(continued next page)

(continued from page 37)

The 1.6 Meg units are IBM-AT compatible and are just entering mass production now; the 2 Meg Teac won't go into production until they get a sizeable request from a large OEM. Most manufacturers are selling their 3.5" drives for about the same price as the 5" equivalents. IBM's new Japanese model (the JX) is using 1 Meg 3.5" drives, and I keep hearing that all of IBM's new machines are going to use them, so look for these fellas to take over a considerable share of the market in the next four or five months.

Skinny Floppies

The other interesting development in tiny drives was the new trend in "super thin" models. These little jewels are almost exactly half the height of a half-height drive, so I guess that makes them quarter-height (can't you just see the ads now? "ALL NEW! Quarter-height, quad density, double sided, half power, double track, half width drives!"). Most companies seemed content with squeezing down only 3.5" models, but Canon had 5" models as well. It doesn't look like 5" drives will be used on new models much longer, but I suppose the super-thins can be used for replacements in existing equipment.

Thin Displays

Floppies weren't the only thin things at Comdex. Thin screens were "in" too. Along with the normal ho-hum LCD screens were a few examples of the new (and expensive) plasma displays and a new backlit LCD screen. The plasma displays are still too expensive and use too much power (although the display quality is heavenly), but the backlit LCD (shown by Citizen) is quite interesting.

Normal LCDs have a black backdrop and when the crystal at a certain spot is rotated, the black shows through. This works, of course, only if there is sufficient light to reflect off the unrotated crystals but not enough to reflect off the black.

The backlit LCD works a bit differently however. Unrotated crystals appear black, while the backdrop is an evenly distributed internal light

source. "Unrotated" is now black and "rotated" is white. Because the light source is always even and always from the same angle, the display remains visible under much more adverse conditions than a traditional LCD display.

Backlit LCDs will probably cost a bit more (but not much) than the normal screens for awhile and they may use just a touch more power, but I would still buy one tomorrow.

Legal BIOS

One company at Comdex was selling a legal BIOS for AT compatibles. Since the Taiwanese are having a tough time getting IBM original software through customs, and Phoenix and the other established companies (even ERSO) are charging outrageous fees (I heard someone mention \$200,000 for a limited license), a New Jersey company has decided to market its own AT BIOS in the Orient. They were talking about \$30,000 for an UNLIMITED license (you can make as many copies as you want).

The company's name was AMI, and it had several other products to sell to OEMs, mostly software and designs for hardware based on the 8088-80386 processors.

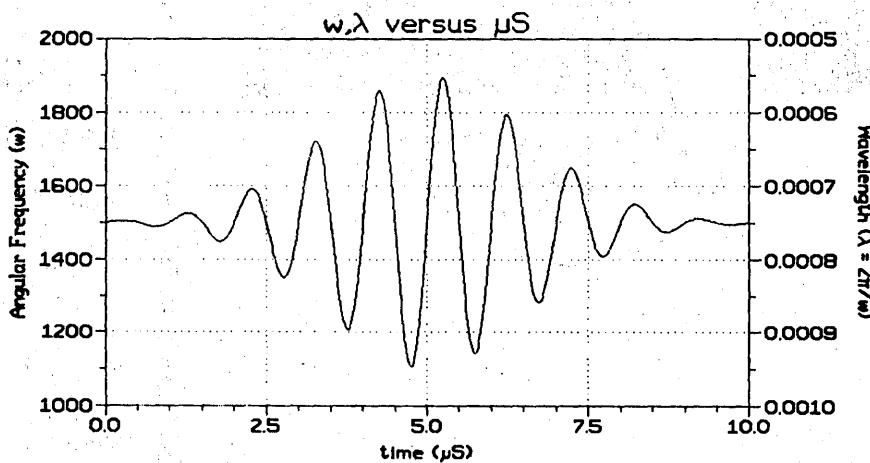
It's a great idea, designing something and then selling the design so you don't have to worry about all the overhead of starting up a factory, but I can see one problem that AMI will have, especially in Taiwan. The problem is that software and hardware designs are intangibles. Most Taiwanese companies we talked to could not quite grasp the idea that intangibles had value; the price of a piece of software should be the price of the media (disk or ROM chip) plus the cost of the labor required to duplicate it. Right?

Who's Who At Comdex

One thing that both Ergun and I noticed throughout the entire exhibition was that everybody who was selling peripherals or software used either IBM original equipment or NEC

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GRAF 3.0: Produces bar, pie, line, scatter, and high/low plots on Epson, IBM, C.Itoh, or NEC compatible dot-matrix graphics printers. Supports 14 fill-in patterns, 8 point-plotting symbols, automatic scaling, labeling, and legend creation. MS-DOS 2 or 3, 192K \$69.95
CP/M-80: Requires 64K (54K TPA) \$49.95

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9801 PCs. The 9801 is NOT a compatible; it is so much better than the IBM that the blue suits should hang their heads in shame. The most notable feature is the system's graphics — resolution of something like 900 x 700 in color mode!

Something very obvious in Japan was that most companies are not so uptight about being IBM compatible (for domestic units) as manufacturers in other countries. One person told me, "We would rather have higher resolution graphics and faster processing." I'm glad SOMEBODY doesn't feel the need to follow along with the "crowd."

MPZ 2060

One of the Japanese companies we'd hoped to see at Comdex was Micro Research. MR's main product currently is a multiuser supermicro called the MPZ 2060. It uses an 80286 processor running at 8 or 10MHz coupled with several 80186 co-processors handling the I/O. It comes standard with 3 Meg

of RAM, a 140 Meg 8" winchester, and Xenix V version 3.2. Expansion cards are connected via a multibus.

In most cases I would just laugh at someone who claimed that their 286 system could handle 16 users. I was skeptical this time too, until I found out about the I/O co-processors. I'm still doubtful about connecting 16 users, but I think the MPZ 2060 would do just great for about six or eight heavy hackers, and even more if some of the terminals spend most of their time twiddling their diodes waiting for the lackey at the desk to type something.

General Impression Of Japan

Overall, I must say that the Japanese companies we dealt with were very formal, full of rules, no nonsense. "If we must then let's do business and get it over with." Most everyone wanted a complete history of our company along with our current economic status and our projected sales for the next five years before they

would even CONSIDER doing business with us.

On To Taiwan

We had met with varying degrees of success/failure with the sample units we ordered from Taiwan. Some had arrived within a few weeks, some took nearly two months, some worked, some didn't. When we arrived in Taiwan, we planned to see a lot of companies and expected to find a few good ones and a LOT of bad ones. We weren't disappointed.

Colonel Cheng's Taiwanese Fried PCs

The first "computer company" we ran across was run by a friend of a friend of our boss. His company actually dealt mainly in chickens and chicken feed. We had been told to contact him for help in getting around in Taipei, but he had somehow gotten wind of the fact we were coming and that we were looking for computers.

(continued next page)

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(continued from page 39)

We called him up from the hotel and he sent a car to get us. When we got to his office, our chicken dealer suddenly became a computer manufacturer. He took us into the next room so that his assistant could give us a test run of the demonstration unit (obviously set up just for us) and we were swept off our feet by the sounds of "Sakura" played by the IBM diagnostics program.

We were deeply moved by the performance but had to throw aside our initial infatuation and force ourselves to leave the building without confirming an order for a thousand units.

How To Meet Companies

Within a day after we arrived in Taipei, before we had talked to anyone except the people at the airport and the hotel, we began getting phone calls.

One of the first persons to be granted an audience with us was an agent for a shipping company. When we asked him how everybody knew our names he showed us a little newsletter that was full of names, including ours. Someone at the airport got the scoop on us from the immigration office and now so did the whole city of Taipei. They knew who we were, where we were from, what we were buying, where we were staying, and probably even our favorite drink.

In other words, in Taiwan, you don't have to find sources; all you have to do is walk off the plane, put "looking for computers" on your immigration form, and make sure you get a motel reservation from the counter at the airport. They'll find you. Of course you may not find the best company that way. We felt that our approach was best; we arrived in Taipei with lots of names, prices, and information. That way if somebody was feeding us a line, we would know.

Our best source of company names was Asian Sources Magazine. Figure 1 gives a list of the few best we found; the worst aren't even worth the cost of the paper to print a list.

By the way, after the third day, the plethora of calls at all hours of the day and night forced us to move to a

different hotel leaving no forwarding address.

We Make SPECIAL Deal For You

Every company seemed to think that it had some unique selling point. They all claimed that they had designed their own hardware, written their own software, and had their own factory "just outside of town." But after a couple of days I began noticing that all the monochrome cards had the same layout, the same manual printed at the same shop, and were packaged in the same box.

The Structure

In reality, almost all of the circuit boards coming from Taiwan are manufactured at one of five or six PC board factories and distributed to "sweat shops" for hand insertion of the ICs.

The ICs, by the way, are sold in packages; for instance a "motherboard chip set" is purchased as a unit from a chip set company and includes all chips necessary for a complete XT motherboard. The companies inserting the ICs have no idea WHY the boards work; they follow the diagram that tells them to put chip D in slot 5 (and light a stick of incense).

After the chips are inserted on the board, the boards are usually run across a small wave-soldering machine, although the smallest companies do their soldering by hand. After the parts are glued into place, there may or may not be testing. If there's testing it's usually the Pacman variety (if the ghosts move then the incense worked).

You may be dealing with a company at any one of these levels. If you happen to find the right one, you will purchase the boards directly from the people who insert the chips (I decline to call them manufacturers). Most of

the computer companies in Taipei are really just trading companies.

Many times a trading company will claim to be the manufacturer. We were even given a tour of "my factory" by a man who ran a trading company. "Later I take you to see my friend who makes Rolex watches. He give you SPECIAL deal! Less than \$30!" You can imagine the support you'd get from one of these companies. So if you're going to buy from Taiwan then you'd better have some schematics and know what's going on, or you're going to learn real quick.

Hardware Prices

Prices varied. Different price didn't necessarily mean different quality, though. The most expensive boards were from Multitech, the largest, most reputable computer company in Taiwan. Multitech was charging about \$200-\$300 more for a complete system (with 20 Meg winchester) than the lowest prices.

The lowest prices were from the chip inserters. Somewhere in the middle were the trading companies. Most trading companies were not a good deal. They offered no extra services for their cut, although one of them, Aquarius Systems, was a decent outfit.

Aquarius Systems specialized in assembling boards from other companies and TESTING them before shipping. One of their systems was based on the Multitech 700 Turbo motherboard, and Aquarius was selling it with one floppy for about \$150-\$200 less than Multitech.

Prices change from day to day, but Figure 2 shows the lowest quotes we got for quantity 100, given by Auto Computer Company, the largest and lowest priced chip inserter we visited. Note that these prices are FOB Taipei for quantity 100.

Figure 2 - Prices From Taiwanese Companies

Turbo (8MHz) motherboard 640K, w/OK installed	\$79.00
Floppy controller card, 4 drives	\$18.50
Hercules mono-graphic card w/printer port	\$42.00
Switching Power Supply, 135 watt	\$42.00
Keyboard, AT layout, Cherry keyswitches	\$33.00
XT flip-top metal cabinet	\$17.00
Monochrome monitor, 12" (Cheer brand, CHEEP)	\$55.00
(Editor's note: I have a "Cheer" and it's just fine.)	

If you hunt you can find better prices (for instance \$51 for 12 inch monitors from Lucky Gold Star in Korea), but it's nice to have to worry about only one LC (Letter of Credit) and one shipment. Definitely shop around. Price, service, and ability to communicate are what counts; design quality won't change at all (and workmanship will change little) from company to company.

Disk Drives

Disk drives are quite expensive in Taiwan, especially winchesters. Purchase these from Japan, the U.S., and Singapore. Floppies are another matter. A \$75 Japanese 5" DD drive cost \$50 or \$60 when manufactured in Taiwan. The best price we found for 3.5" 1 Meg drives was \$85 from Toshiba in Hong Kong where I bought my T1100. But Ho Shin of Taiwan is planning to start production of their own 3.5" 1 Meggers for about \$60 each.

Is There A REAL Legal BIOS?

Now for the software. You've probably heard lots of rumors about software piracy in Asia. Well, I have to tell you that none of it is exaggerated even a little bit. We must have seen at least 20 retail shops selling everything from AutoCAD to Xenix for \$5 per disk.

That didn't really bother me though, after I thought about it. A few guys selling a few copies of CCP/M to poor Taiwanese students who wouldn't have bought if they had to pay retail anyway can't do much harm.

What bothered me was the 10 or so companies who were selling copyrighted software to their distributors and dealers all over the world, perpetrating the software to such depths that nobody may ever sell another software product again.

Government Actions

The U.S. government says it's taken action, and apparently it's been enough to put a scare in most of the computer companies in Taiwan. They have no qualms about shipping any BIOS, legal or illegal, to any country, EXCEPT the U.S.

(continued next page)

Figure 1 - A Short List Of "Good" Companies

Bison International Co. Ltd.
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Prices nearly as good as Auto C.
BIOS is "in house" & will be
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Taipei, TAIWAN R.O.C

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tel: (02) 393-4568-9
tlx: 11888 APEXELC

Possibly MSDOS, but
check it out thoroughly

Aquarius Systems
6F, No. 394 Keelung Rd., Sec. 1
Taipei, TAIWAN R.O.C.

No engineers, but
incredibly high volume.
Trading company, but good.
Manager speaks GOOD English.
500 series uses Multitech mboard
(and includes licensed MSDOS and
BIOS)(Multitech insists)

P.O. Box 48-29

tel:(02)706-9140
tlx:13138 AQUSYS

Prestico Associated Corp.
9F, 41-2 Shin-Yi Rd., Sec. 3
Taipei, TAIWAN R.O.C.

Not best prices, but a nice guy.
Trading company

P.O. Box 7-559

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- UNIQUE to ED/ASM is its structured assembly language capability. No more wasted labels and time! Multiple segmented programs can be sent to .COM files.
- * The built in debugger supports symbolic disassembly, integration with the assembler, as well as disassembly of 8087/186/286 instructions. Display 8087 registers in scientific decimal format. SPLIT SCREEN debugging with a dynamic register window is easily invoked. Disassemble programs to disk file for easier analysis. "Single-step" data editting supported for bytes, words, double words, and 8087 floating constants in memory. You can "patch" assemble a line at a time with symbols from previous assembly (even define symbols as you go!).
- * The linker supports ED/ASM-86 link files, which can be created from virtually any valid ED/ASM-86 source file, even lines with multiple external symbols in expressions. (Note: not compatible with usual link format)
- * And many more features too extensive to be listed here.

All of these features exist in one integrated program. A typical development cycle with ED/ASM-86 consists of entering a program with the editor, or editting an existing program, typing "A:IM" to assemble into memory, going into the debugger to immediately test the program. Then you go back to the editor for the next cycle. ED/ASM was developed for Oliver Computing's own use, and has been used for over a year to enhance itself!

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86 WORLD

(continued from page 41)

The Taiwanese government also has addressed the situation by prosecuting people who copy IBM software. An example might help to illustrate the point.

While talking to all the companies, I got into the habit of asking them whether their BIOS was legal or not and who the source was. At one company I was told, "Yes, it's legal."

Then I asked, "Does that mean that, for example, I could take this BIOS through U.S. Customs and it would pass?"

"Oh, no. You can't do that."

"Then it's NOT legal."

"Oh, yes, it's legal. You just can't take it through U.S. Customs. We might get in trouble."

That confused me a little until I talked with another company:

"Our BIOS has no copyright problems at all."

"Did you develop it, or are you licensing someone else's?"

"Oh, we copied it from UITRA."

"Then it's illegal."

"No, no copyright problems. It's not IBM original. If it was IBM original then we wouldn't be able to send it on the board, but since it's not IBM, Taiwanese Customs doesn't mind. Do you want IBM original? We can supply

it, but we will have to send it air mail separate from the rest of the system. They don't check there."

So, "legal" actually means "not IBM." And "copyrighted" means "somebody copyrighted it." So beware when you are told "our BIOS is copyrighted." It still could be stolen.

BIOS Source

By the way, Gary mentioned ERSO in issue 29. The story he gives isn't exactly the whole story. ERSO (Electronic Research and Something Organization) was actually put together some time ago to help all electronics oriented companies. Currently their work involves mostly computer companies, and they design disk drives and other things.

On the outside, ERSO looks like a public service organization, but they've gone commercial. Many Taiwanese companies are not purchasing the ERSO BIOS because they say it's too expensive. Instead, they're getting a license from someone else or just copying it.

There are at least eight different BIOSes floating around in Taiwan — IBS, UITRA, Super Computer, Mega XT, ERSO, ARC, Phoenix, and of course, IBM. Many of these are just copies of one another; but they're changed enough to be legal.

Speaking of changing to be legal,

that's what ERSO apparently did. When IBM got mad and started hunting for pirates, one of their first victims was ERSO. So ERSO modified the old BIOS so it wasn't quite compatible (i.e., some things don't work). That's what I heard, anyway.

MS-DOS

If you're looking for a legal MS-DOS license in Taiwan, forget it, unless you're dealing with Multitech (and possibly Aquarius). It just don't exist. Well, it does in some places, but it's difficult to tell who is selling you a license and who is selling just a disk. It's all the same to them. Best bet would be to buy the boards without MS-DOS and buy PC-DOS. It's a bit more expensive (licenses coming with equipment can be as low as \$15), but it's safer.

That's it for now. Allahasmarladik (ciao, baby). Pray for sun at SOG.

Editor's notes: Laine is trying to make it to SOG V. If he does, SOG attendees will get a look at the guts of the international trade and copyright business — and Turkish computer technology — that will blow their turbans off.

Also, I published an old address for the import broker I mentioned in Issue 29. The real address is: Newman Wilson Co

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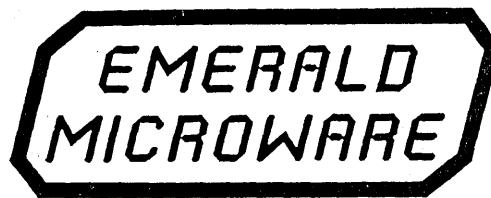
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256K RAM Upgrade For 83 Kaypros

I've received numerous requests from those of you who have wanted to build a RAM disk into your 83 Kaypro. My stock answer was that this kind of project didn't lend itself to homebuilding since RAM chips are so sensitive to noise on the supply and signal lines.

However, the good doctor has elegantly solved that problem by installing 256K chips in place of the original 64s. I wish you all much luck and little static while doing this fine project.

An article in the September 1985 issue of Byte describing a 256K upgrade for the Atari 800XL prompted me to try a similar hardware hack on my pre-84 Kaypro 4.

Although I encountered a number of problems I now have a Kaypro with 256K RAM. The resulting improvement in performance has far surpassed my expectations.

Perfect Writer can now handle large files without protracted bouts of swapping and missing keyboard input. INFOCOM games run in eerie silence with no disk drive motor noise and respond almost instantly. And I've even buffered my CCP and BDOS so that a warm boot is twice as fast.

The 256K RAM in my machine has been working perfectly for around six months now.

Danger Down Under

This wasn't the first time I'd taken the lid off my Kaypro and delved inside. Within a year of buying it, I'd speeded the CPU up to 5MHz, added a ProMonitor 8 ROM, installed a ZTIME-1 clock board, and fitted it with twin Mitsubishi quad drives.

However, fitting 256K RAM chips with address decoding, bank switching, and refresh was certainly the most frightening upgrade I've ever per-

formed, since I was breaking new ground (for me) rather than following a proven design. As a result I learned a lot, some of it the hard way.

In the hope that I can spare others some of the worry and stress I suffered, here is a step by step guide on how to turn a Kaypro into a Kaypro 8-256.

Kaypro 2 Or 4?

Although the case of my Kaypro proclaims it to be a II, it has a Kaypro 4 motherboard, as I discovered when my first Micro C ProMonitor ROM didn't work (they exchanged it for the correct one straight away and explained what had happened).

The circuit in Figure 1 should work with most Z80 machines that use 64K dynamic RAMs. However, the connections shown in Table 1 are obviously specific to the Kaypro 4 motherboard. If you have a different Kaypro model you may need to consult a schematic to locate specific signals.

This modification does involve fairly extensive surgery and an understanding of dynamic RAMs, so if you're not confident you can carry it out, get a friend who knows what he's doing to help (i.e., supervise).

Most of you are aware of the potential for static damage to ICs. And if you're like me, you may have become a little blasé about warnings. But be warned — 256K chips are among the most sensitive and easily damaged ICs you're likely to encounter.

If you want a reliable system and don't like wasting money take full precautions. I bought my chips from Microprocessors Unlimited, who provided good instructions for handling ICs. They also have low prices and high quality parts.

The Mod

After unplugging your machine and removing the lid and the motherboard, carefully unsolder the eight 64K RAM

By Dr. Michael W.D. Liddle

21 The Frostings
Grenoside
Sheffield, S30 3NZ England

Table 1 - Connections Between Add-On Board and Main Processor

Signal On New Board	Connection on 83 main board
REFRESH	U48 pin 12
MUX	U33 pin 1
A14	U33 pin 11
A15	U33 pin 10
RA7*	U20 pin 9
RA8*	U20 pin 1
PIO 1	Pad E29
PIO 2	Pad E28
PIO 3	Pad E31

*Outputs from new board

Note: Only 83 Kaypros have spare PIO control bits. 84 series would need additional latch & latch port decoding.

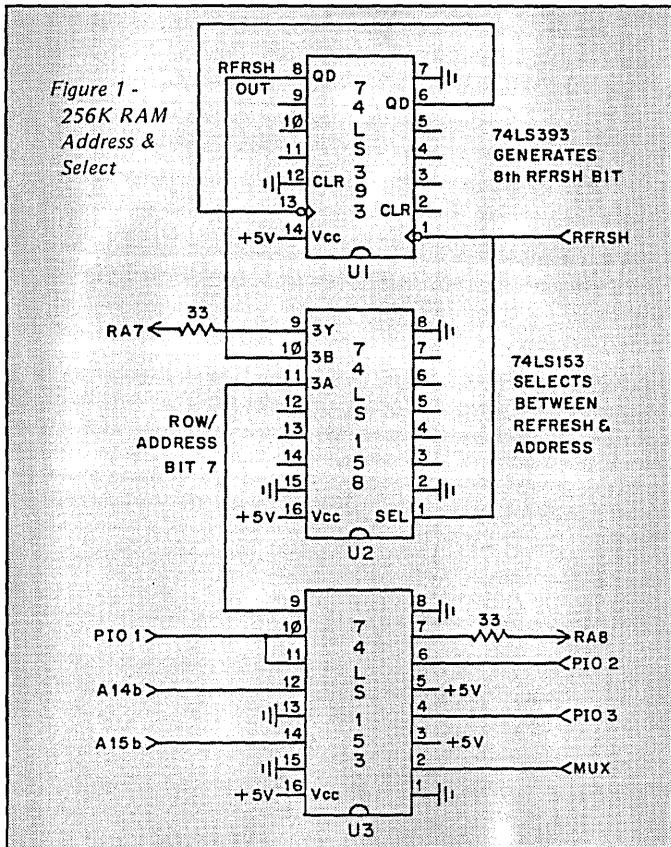
chips. (If they're in sockets, you probably shouldn't unsolder them.)

Unsoldering will take several hours and must be done delicately. Don't use too much heat; don't use more than minimal force; and don't rush. Use proper tools. A solder sucker and proper iron are essential. (Editor's note: The easiest way to remove 16-pin ICs is to cut the pins off the body first and then heat and remove them one by one.)

Whenever you make any modifications to a circuit you should proceed stepwise and test at each stage as a matter of routine. So having removed the chips, check the board carefully for damage.

Then install eight 16-pin sockets in place of the RAM chips, and plug 64K RAM chips into them (you could plug in the originals here if you didn't cut off the leads but you might be smarter to have a new set of eight 64's for this step). Check that they're the right way up and that no pins are bent out or folded under. After checking a second time, switch on and all should work as it did before.

Run your stiffest memory tests. If all isn't fine, check that the chips are in correctly, that solder joints are good,



and that no bridges of solder are shorting out tracks. Also make sure that no tracks have been damaged, and try again.

Finally, if it still doesn't work, try swapping in a set of 64K RAMs that work in another machine. Don't proceed further until your machine works correctly.

If all is working, disconnect again and wire all the pin 1s of the RAM sockets together under the board. On my Kaypro these are not connected to anything; make sure that the same is true on yours.

If your board has pin 1 of the RAM chips connected to ground, +5V, or anything else, then bend pin 1 out and wire the pin 1s of each chip together (when you plug in the 256K chips). Anyway, this is RA8, the 8th address line to the 256K RAM chips.

Now remove resistor R9 so that the RA7 signal is no longer connected to the address line multiplexer U33.

Make the circuit shown in Figure 1 on prototyping board. (Radio Shack sells suitable boards.) Connect the circuit to your Kaypro motherboard according to the wiring instructions in Table 1. Don't forget ground and +5V, and don't get them turned

around (I did the first time).

Now power up your motherboard (the 64K RAM is still in place). Everything should work as before. Run your stiffest hardware test programs. Use your machine extensively. When you're happy that all works as it should, replace the 64K chips with 256K chips. Test your machine again. If it works, you now have a Kaypro 8-256!

The circuit is similar to that in the September Byte and I advise you to get and read it first.

U1 is a twin 4-bit binary counter, and these are wired together as a divide by 64.

The refresh signal is fed through this to produce the eighth bit of the refresh address for the RAM chips.

Although the Z80 has an 8-bit refresh register, it only provides a 7-bit refresh address. U3 is a twin 4 line to 1 multiplexer.

This carries out bank switching to produce the new RA7 and RA8 for the RAM. It also ensures that the same bank is selected whenever an access is made to the top 32K of RAM. U2 combines RA7 with the refresh address generated by U3 producing the new RA7.

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Software

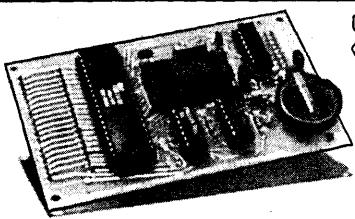
Your Kaypro will behave no differently until you install software which uses the extra memory.

I chose to modify my BIOS to provide a 160K RAM disk, 26.5K printer buffer, and 5.5K CCP and BDOS buffer. This works well for me, but you may wish to be more ambitious and rewrite the BIOS to provide track buffering which, while a better way to use RAM, requires a lot of assembly language programming. If you do it, then I'd really appreciate a copy.

Note that plenty of multiplexer is left over on IC2 for modification to use 1 megabit chips. And with 150 or 120 nanosecond parts there would be room for a further CPU speedup to 8MHz with a Z80H.

You might ask, "Why go to all this trouble to install a 160K RAM drive when MicroSphere offers cheap RAM drives with up to a Meg of RAM. My answer: "It's fun; it's educational; and it cost me less than \$40."





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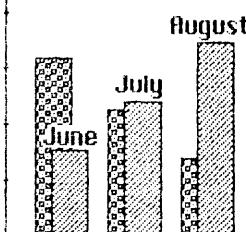


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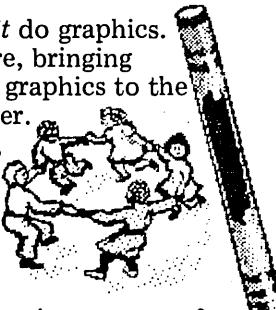


"Kaypro makes a nice computer— too bad it doesn't do graphics!"

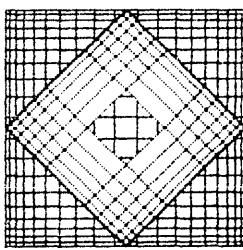
Graphic
Designer



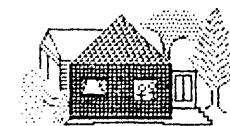
Make that *didn't* do graphics. SCS-Draw is here, bringing Macintosh-style graphics to the Kaypro computer. With SCS-Draw, you can use your Kaypro to draw a picture. Of anything.



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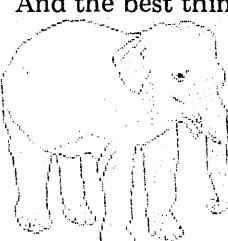


The first true drawing program for the Kaypro, SCS-Draw turns your computer screen into a sketchpad on which you can draw detailed images like those shown here. These images can be saved on disk or printed on your dot-matrix or letter-quality printer.



There are many applications of SCS-Draw. For example, you could use SCS-Draw to design and print party invitations, banners, or technical diagrams. You could also use SCS-Draw to promote your business or design your company logo.

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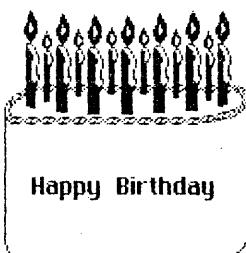
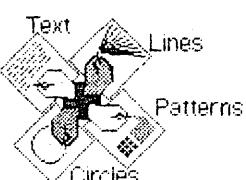
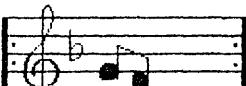
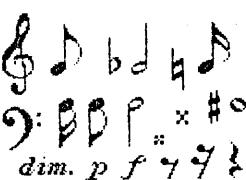


How good is SCS-Draw? Every day, we get unsolicited letters and phone calls from SCS-Draw users around the country — here's what *they* have to say:

- "Very easy to use."
- G.H., WPAFB, Ohio
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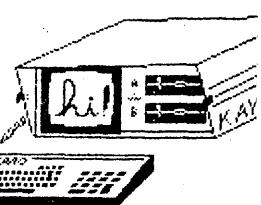
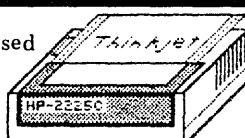
Happy Birthday

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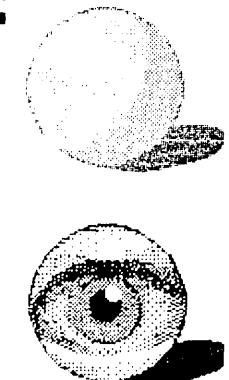
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SCS-Draw can be used with most popular dot-matrix and letter-quality printers, including those from Epson, Star, Okidata, C. Itoh, Panasonic, IBM, HP, Diablo and Kaypro.

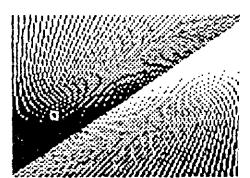


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Doodling On A Hercules Board

By John P. Jones

6245 Columbia Ave.
St. Louis MO 63139
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Turbo Pascal makes the movement between CP/M and MS-DOS systems almost trivial. The "almost" part is what John talks about this time. Following that is the code to support doodling on a Hercules display with a joy stick. Some fun along with the work.

I have resisted getting an MS-DOS machine (read "IBM compatible") for several reasons. The most important of these is that until recently, the price-performance ratio has not compared well with Z80 based designs. Also, because of my personal bias against Big Blue I've ignored many of the good points of the machine and software designs.

It is still true that many application programs will run more efficiently on a 4MHz Z80 than on a stock PC, mainly because of the Z80's 64K memory limit. Programs for the smaller address space have to be written to be compact and efficient; otherwise they would not even be possible, much less useful. Many application programs for the PC are "core hogs" badly in need of streamlining.

Why then am I writing this column on a PC clone? First, with the 8MHz clock option and an NEC V20 processor, the machine is not nearly as stodgy as the stock machine. Next, I got the machine at an extremely good price, i.e. I traded some of my time for it. Most important, however, is future software. Although there will continue to be software developed for CP/M-80 machines, new titles are dwindling and will eventually fade into oblivion. Conversely, new software for the PC will be showing up for years after Big Blue has abandoned the product line.

I still have my Big Board I, and continue to use it for several tasks. It would be prohibitively expensive to buy all the equivalent software for the clone, so the transition will be quite

gradual. With a communications and terminal emulation program I can use the PC as a terminal for the CP/M-80 machine, so I need only one CRT and keyboard.

I must admit there are some things about MS-DOS that make working in the PC environment very convenient, even fun. As I type this, every once in a while the machine quietly beeps to let me know it thinks I've misspelled something. The gem that makes this possible is Borland's Turbo Lightning, a product I can highly recommend. Once loaded, it can continually check your input for spelling errors, and when found, two or three keystrokes are all that are needed for correction.

The Pascal Transition

I have a substantial library of Pascal code developed in the CP/M-80 environment. Since I have a winchester on the clone, most of it will eventually be transferred. What kinds of problems are likely to occur in the migration between the machines? I'm assuming that the primary problem of moving the data and source has been solved. In addition, since it has become the de facto standard for microcomputer Pascal, I'm assuming that the conversion will be between CP/M and MS-DOS versions of Turbo Pascal.

Data Files

The only data files directly compatible between the two operating systems are TEXT files and untyped files. This is because all typed files for CP/M have a 4 byte prefix before the first record. This prefix contains the record length and record count for the file. This information cannot be derived directly from the disk directory entry as it can for MS-DOS. If you are not using 8087 Turbo or Turbo BCD, the actual data will be compatible between the two file systems.

For DOS, "file of byte" is compatible with any file. A short file copy

program written in MS-DOS Turbo which discards the 4 byte prefix is all that's needed to get to work again.

Programs

The degree of difficulty in moving programs will depend on three major factors. First, if your programs use only standard features and extensions, there may be no translation needed at all. Two situations which may need significant massaging are operating system specific and processor specific extensions.

Processor Differences

The processor specific extensions fall into two classes. One class is the INLINE statement; obviously the translation will involve conversion from one processor's machine code to the other. The other class includes all statements that either return addresses or have addresses as arguments. Eight-bit processors have a 64K address space, accessed through a 16-bit address. Integers are also represented with 16 bits, so conversions between addresses and integers are fairly straightforward. The 8088 can address a full 1024K of memory, so this needs a 20-bit address. Because of the way the 8088 is structured addresses are represented with 32 bits, a 16-bit segment value and a 16-bit offset within the segment. Turbo Pascal for the 8088 understandably does the same.

Where changes will need to be made:

1. All references to the pre-defined array MEM.
2. Addresses for ABSOLUTE variables.
3. ORD cannot be used on pointers for the 8088; use SEG and OFS for the variable pointed to instead.
4. MEMAVAIL returns its value in PARAGRAPHS, each 16 bytes.
5. ADDR can be used only for variables, not procedures or functions. You can use OFS for these, along with

CSEG which returns the code segment value.

Also, EXTERNAL procedures are handled quite differently for the two processors.

Operating System Differences

CP/M-80 provides services to application programs through a standard CALL, and secondarily, allows calls to its machine specific extension, the BIOS. CP/M-86 and MS-DOS use standard software interrupts for these services. If the equivalent service is available, conversion of the software is a fairly simple change to the corresponding procedure or function for the other operating system.

1. BDOS and BDOSHL are replaced by MS-DOS (BDOS for CP/M-86). Set-up for the call is quite different and will have to be changed.

2. BIOS and BIOSHL are replaced by INTR, which generates a software interrupt for the selected function.

Since MS-DOS versions 2 and above have a tree structured directory, the OVRDRIVE procedure has been changed to OVRPATH.

So far, I haven't had too many problems in the conversion. Most difficulties have been with "fancy" and non-standard software.

The Fun Part

I've been spending a bit of time exploring the capabilities of the new system. Since I spend most of my time on the machine in text mode, I decided on a monochrome display/adapter combination because of the higher quality text. On the other hand, the computer is, in part, a toy so the monochrome graphics capabilities of the Hercules style video card was my final choice.

I've ordered the Turbo Grafix Toolbox (which supports the Hercules) but it hasn't arrived yet. In the interim, a set of graphics routines for the Hercules can be downloaded from the Borland SIG on Compuserve. (The files to download are HERC.SUB, HERC.DOC, and HERCDE.PAS.) This set of subroutines provides the basic tools for monochrome graphics. In addition, text at 90 X 43 is available in graphics mode.

At the urging of the kids (it didn't take much) I wrote a program to

*Listing 2 - Routine To Adjust A Self-centering Joystick
For Zero Offset When At Rest*

```
program adjust_center;
{ First run the program to find
  values for max X and Y deflection,
  then adjust your centering controls
  to the middle of the range. Re-run
  the program & adjust for = deflection
  for both directions of stick movement.}

var
  x,y : integer;
  centerx,centery : integer;

procedure readstick(var x,y:integer);

var
  i : integer;
  pots : byte;

begin
  x := 0;
  y := 0;
  port[513] := 0;
  for i := 0 to 63 do
  begin
    pots := port[513];
    x := x + (pots and 1);
    y := y + (pots and 2);
  end;
  y := y shr 1;
end;

begin
  readstick(centery,centerx);
  while true do
  begin
    readstick(y,x);
    y := y - centery;
    x := x - centerx;
    gotoxy(1,23);
    write('X = ',x:4,' Y = ',y:4);
  end;
end.
```

doodle on the screen. But it wasn't very exciting using just cursor control keys, so I bought a Commodore joystick, did a little rewiring, and came up with the program in Listing 1. One note of caution: I'm not sure that my rewired Commodore joystick is totally compatible with a real IBM joystick, so you may need to modify the READSTICK routine to work correctly.

Listing 2 can be used to adjust a self-centering joystick for zero offset when

at rest. READSTICK does not give very high resolution for stick position, but in this application more is not necessary. If you need higher resolution, a machine language routine would be best.

Note: Listing 1 on pages 50 through 53.



LISTING 1 - SKETCH PROGRAM FOR SCREEN DOODLING

```
program sketch;

{$i herc.sub} { Include support for Hercules style graphics.}

label 0;
const
  maxx = 719; { pixels across in range of 0..719 }
  maxy = 330; { vertical range 0..347, leave room for prompt line at bottom }

var
  centerx,centery : integer; { center position joystick values, allow +/- offsets from center }
  x,y,x1,y1, xi,yi,colr : integer; { current pos, target pos, position increment, and 'color' black or white}
  ch : char; { for keyboard input }
  switch : boolean; { fire button(s) on joystick }

procedure cursor(x,y : integer);
{ This procedure draws or erases a triangular drawing cursor at the current drawing position. A 'color' > 127 will XOR with the background. This means that the cursor can be drawn on top of existing pixels without losing the information to restore them when the cursor is later moved. }

begin
  draw(x,y,x-5,y+10,128); { x & y are the top point of the triangle }
  draw(x-5,y+10,x+5,y+10,128);
  draw(x+5,y+10,x,y,128);
end;

procedure savescreen;
{ Save a drawing to a file. Just reads the screen memory (32K) and writes it to a file for later restore. }
var
  picture : file; { untyped file }
  screen : array[0..$7fff] of byte absolute $b000:0000; { note seg & ofs }
  picname : string[30]; { allow for 'path' name for file }

begin
  gotoxy(1,43); { to bottom text line }
  write('Name of picture file: '); { prompt for file }
  cursor(x1,y1); { erase drawing cursor, don't want it in the picture }
  read(picname); { get filename }
  if pos('. ',picname) = 0 then picname := picname + '.pic'; { default file type}
  assign(picture,picname);
  rewrite(picture);
  gotoxy(1,43); { erase prompt, don't want it in picture either }
  clreol;
  blockwrite(picture,screen,256); { use high speed file write, 256 * 128 bytes }
  close(picture); { now we're done }
  cursor(x1,y1); { restore cursor }
end;

procedure loadscreen;
{ Performs the reverse operation to SAVESCREEN above with one exception, for some reason, a BLOCKREAD from a file directly to screen memory doesn't work. A read into a temporary variable followed by a write to the screen does the trick. Any suggestions as to why the direct file to screen doesn't work? }

var
  picture : file;
  screen : array[0..$7fff] of byte absolute $b000:0000;
  temp : array[0..$7fff] of byte;
  picname : string[30];
```

(listing continued on page 52)

HANDYMAN

TURN YOUR KAYPRO ON TO **HANDYMAN!!!**

AUTO DIALER

- Use your modem to make phone calls automatically without exiting the program you are already working on!!

NOTE PAD

- Write a note, paragraph, letter, a whole file; anytime, from within any other program!!
- Edit another file without leaving your current file!!

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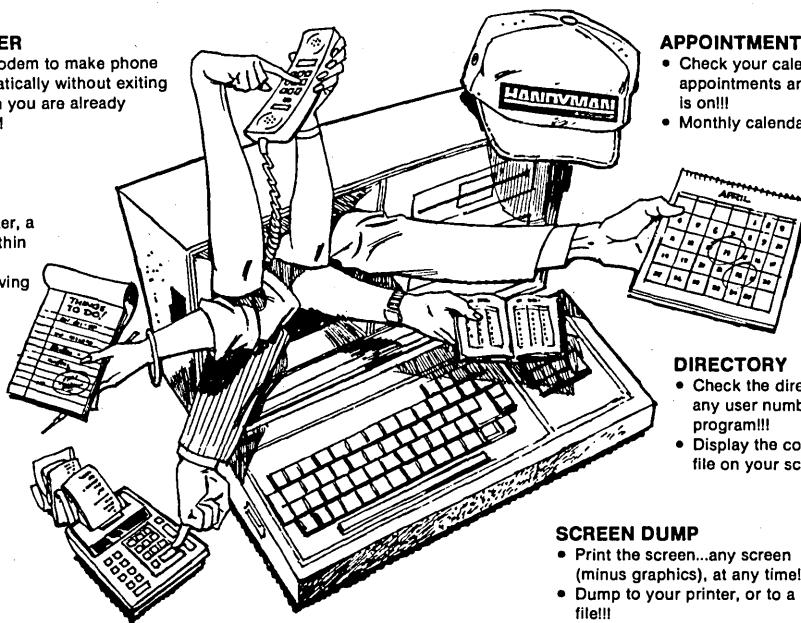
Peter McWilliams
The McWilliams Letter
January 1986

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```

begin
  gotoxy(1,43);
  write('Name of picture file: ');
  cursor(x1,y1);
  read(picname);
  if pos('. ',picname) = 0 then picname := picname + '.pic';
  assign(picture,picname);
  reset(picture);
  gotoxy(1,43);
  clreol;
  blockread(picture,temp,256);
  move(temp,screen,$7fff);
  close(picture);
  cursor(x1,y1);
end;

procedure printscreens;
{ Dump graphics screen to printer. This procedure is quite a bit more
complex than the file save/restore procedures above. The graphics screen
is not a linear array of pixels but is actually 4 interleaved 8K byte
arrays. This means that the pixel on the dot row immediately below the
current pixel is actually 8K+90 bytes (90 bytes per/row) away in the
linear address space. In addition, conversion has to be made between row
scan (screen) and column scan (printer). }

var
  screen : array [0..3,0..$1fff] of byte absolute $b000:0000;
  inp, out : array [0..7] of byte;
  i,j,k,l : integer;

begin
  cursor(x1,y1); { keep the cursor out of the picture }
  write(lst,['','3',chr(15)); { set 15/144" line feed }
  for k := 0 to 43 do { actually 43.5 sets of 8 rows }
    begin
      write(lst,['','L',chr(208),chr(2)); { 720 pixel columns/row }
      for i := 0 to 89 do { 90 eight byte cells/row }
        begin
          for j := 0 to 3 do { get top 4 bytes of cell }
            inp[j] := screen[j,i+(k*180)];
          if k < 43 then { if not last row, get bottom 4 }
            for j := 4 to 7 do inp[j] := screen[j-4,i+(k*180)+90]
          else for j := 4 to 7 do inp[j] := 0; { else blank bottom 4 }
          for j := 7 downto 0 do { horizontal to vertical conversion }
            begin
              out[j] := 0; { blank output byte }
              for l := 0 to 7 do
                begin
                  out[j] := out[j] shl 1 + ord(odd(inp[l])); { merge low order bit }
                  inp[l] := inp[l] shr 1; { shift in next bit }
                end;
              end;
              for j := 0 to 7 do { output 8 to printer }
                write(lst,chr(out[j]));
            end;
            writeln(lst); { ready for next row }
        end;
        cursor(x1,y1); { cursor back for drawing mode }
    end;
  procedure readstick(var x,y:integer;var switch : boolean);
  { Read joystick position. A write to the joystick port triggers the
one-shots connected to the variable resistance of the joystick pots.
The outputs of the one-shots will remain high for a time proportional
to the pot resistance. The X one-shot comes in on bit 0 and the Y on
bit 1 while the 'fire' buttons are on bits 4 & 5. Inputs from the fire
buttons will be low when pressed.}

```

```

var
  i : integer;
  pots : byte;

begin
  x := 0;           { initialize values }
  y := 0;
  port[513] := 0;   { trigger one-shots }
  for i := 0 to 40 do { loop length determined by trial & error }
  begin
    pots := port[513]; { get current value }
    x := x + (pots and 1); { sum in x one-shot }
    y := y + (pots and 2); { and the y }
  end;
  y := y shr 1;      { y comes in on bit 1, divide by 2 to
                      { get same range}
  switch := (pots and $30) xor $30 <> 0; { does NOT distinguish the
                                              { switches, either returns true.}
end;

begin
  colr := 1;          { any 'color' 1..127 is visible }
  readstick(centery,centerx,switch); { get center values for stick }
  hires;              { graphics mode }
  x1 := 359;          { start cursor in center of screen }
  y1 := 173;
  cursor(x1,y1);     { show the cursor }
  while true do        { loop forever }
  begin
    readstick(yi,xi,switch); { new stick position }
    yi := yi - centery; { convert to +/- offset }
    xi := xi - centerx;
    if (abs(xi) > 1) or (abs(yi) > 1) then { stick 'chatters' a bit }
    begin
      x := x1;          { so ignore changes < 1 }
      y := y1;          { new current position = old dest }
      x1 := x + xi;    { calculate new destination }
      y1 := y + yi;
      if x1 > maxx then x1 := maxx; { don't let us go off screen }
      if y1 > maxy then y1 := maxy;
      if x1 < 0 then x1 := 0;
      if y1 < 0 then y1 := 0;
      cursor(x,y);     { kill old cursor }
      if not switch then draw(x,y,x1,y1,colr); { if not pen-up draw line
                                                { between current and dest }
      cursor(x1,y1);     { cursor at new position }
    end;
    delay(50);
    if keypressed then { it's a bit fast without this }
    begin
      read(kbd,ch); { check for keyboard command }
      case ch of
        'q','Q' : goto 0; { get command char }
        'e','E' : colr := 0;
        'd','D' : colr := 1;
        's','S' : savescreen;
        'l','L' : loadscreen;
        'p','P' : printscren;
        'c','C' :
        begin
          hires;
          cursor(x1,y1);
        end; { case ch of... }
      end; { if keypressed then... }
    end; { while true do... }
  end;
  0:
  textmode;
end.

```

End of Listing

PC-DOS For Non-Clones

Writing A Custom BIOS Interrupt By Interrupt

CP/M-80 systems aren't the only ones affected by the market's strong move toward PC-DOS. Even 8088/8086 based systems such as Fred's S-100 have been left without support.

In this article Fred covers, step by step, what he went through to write a PC-compatible (or mostly compatible) BIOS for his system. In the process he learned a lot about PC-DOS. This is a cook's tour of PC-DOS that no self-respecting technical type should miss.

Was my system obsolete? Did I need to replace it with a new one? These questions had been running through my mind for quite some time. My dual processor S-100 system running CP/M-80 and CP/M-86 had served me, but most of the new developments were centered around PCs running PC-DOS.

I didn't really want to replace the computer, but it seemed I needed at least some degree of PC compatibility to keep up.

Since one of my processors was an 8088 I decided the easiest and least costly route was to get the PC- (or MS) DOS operating system to run on my hardware.

So For Starters

I obtained the IBM hardware reference manual, which contains a complete listing of the BIOS ROM used to interface PC-DOS to the IBM hardware.

After studying the manual, I concluded that there was a good chance that PC-DOS would run on my hardware. This article describes the results of that effort and outlines the steps required to implement PC-DOS.

By following this procedure an experienced assembly language programmer should be able to implement PC-DOS on any 8086 computer system.

The resulting system is best de-

scribed as generic PC-DOS. Software designed for the IBM-PC (or compatibles) which uses only normal DOS system calls to perform I/O functions will run properly. Software which uses unique features of the machine, such as graphics, or software which accesses the hardware directly, will not run properly.

Requirements & Approach

In order to run PC-DOS you'll need either an 8088, 8086, 80186, or 80286 CPU, 128K RAM, a 5.25" disk drive and controller (DD), a terminal or other form of console device, PC-DOS version 2.1, a text editor, an 8086 assembler, linker, and loader.

The PC contains the primitive I/O functions for accessing the various components of the hardware in its BIOS (Basic Input/Output System) ROM. This ROM contains all the routines for accessing the available standard hardware.

The routines are accessed via software interrupts, so their physical location isn't critical to proper operation of PC-DOS. If the routine is moved, you need only adjust the interrupt vectors to access the routine at its new address.

The BIOS

I had to write a BIOS module to provide the I/O functions for my hardware. In it I tried to adequately support normal PC-DOS function calls and to return harmless values for those functions which return information unique to the PC's hardware.

This new BIOS is loaded into RAM from CP/M-86 in my system, but it could be placed in ROM so that it's always available. The BIOS includes the boot routine to load PC-DOS from disk and to begin its operation.

The normal location for the BIOS code is at the top of available memory. This leaves the largest possible block of contiguous memory for PC-DOS. It

isn't necessary for the BIOS code to be in a contiguous portion of main memory. On the IBM-PC it's located in the top 8K of the 1 megabyte address space of the 8088 microprocessor.

DOS can use a maximum of 640K of memory so there's a large gap between DOS and the BIOS. If you want to put the BIOS code in ROM, this is a good approach to use.

Interrupts

You can implement PC-DOS either with interrupt driven I/O or with polled I/O. I set up hardware interrupts for the keyboard and a clock only. The interrupt driven keyboard provides a type ahead capability, but isn't necessary for operation of DOS. The clock maintains the time and date.

The IBM-PC uses software interrupts hex 10 through hex 1F to access the BIOS ROM functions. PC-DOS reserves software interrupts hex 20 through hex 3F for its use. Interrupts hex 08 through hex 0F are reserved for the various hardware components contained in the PC. Interrupts hex 00 through 07 and interrupts hex 40 and 41 are also reserved. If you're using a system with hardware interrupts, they should not use any of these values.

If your hardware uses a non-programmable approach to hardware interrupts and a conflict exists, you need to provide some means of distinguishing between a DOS generated software interrupt and a hardware interrupt. This greatly complicates the problem.

BIOS Initialization

The first function I implemented in the BIOS was initialization of the interrupt vectors. Even if you're not using hardware interrupts, the interrupt vectors must be initialized since all the BIOS functions are accessed through software interrupts.

After the interrupt vectors have been set, I initialize the few memory varia-

bles required by the BIOS. These variables are defined in the detailed descriptions of the BIOS interrupts and in the BIOS listing. The BIOS uses a low address memory segment for data storage. I don't recommend changing the data segment location, since that's where PC-DOS expects it.

Next, initialize the system hardware. This includes setting the serial device baud rates, data bits, parity, etc., and initialization and start up of the clock. Interrupts are then enabled and the boot routine to load DOS is entered via a software interrupt.

Interrupt Descriptions

Data is passed to the software interrupt handlers via the CPU registers and returned from the handlers both in the registers and in the processor flags.

The following descriptions define the functions performed by each software interrupt, the data passed to it, and the data returned from the routine.

Interrupt 10 — Video Output

This is one of the most complex interrupt handlers in the PC BIOS ROM. It provides support for both simple character output and black/white and color graphics. Since I have an ASCII terminal, I wrote my BIOS to support only simple character output.

The function to be performed is passed to the interrupt handler in the AH register. A total of 15 functions are supported by the PC ROM BIOS. These functions, along with the action taken by my generic BIOS, follow. My BIOS ignores 00, 01, 02, 03, 04, 05, 06, 07, 11, and 12.

AH-00 — Sets black and white or color output, as well as character or graphics mode.

AH-01 — Sets the cursor type used by the PC.

AH-02 — Sets cursor position.

AH-03 — Reads the cursor position. This function is ignored by my BIOS, and always returns a value of zero.

AH-04 — Reads the light pen position. This function is ignored by my BIOS. It returns zero to indicate no light pen.

AH-05 — Selects the active display page.

AH-06 — Scrolls the active page up.

AH-07 — Scrolls the active page down.

AH-08 — Reads the attribute/character at the current cursor position. My BIOS returns AX=0 (character and attribute) and BH=0 (active page).

AH-09 — Writes the character/attribute at the current cursor position. My BIOS treats this as normal character output. The main difference is that the PC BIOS does not advance the cursor position for this function (or for function 10), and my BIOS does. The character to be output is in the AL register.

AH-10 — Writes the character at the current cursor position without advancing the cursor. My BIOS also treats this as normal character output. The character to be output is in the AL register.

AH-11 — Sets the color palette.

AH-12 — Write graphics dot.

AH-13 — Read graphics dot. My BIOS always returns AL=0.

AH-14 — Teletype (TTY) output. This is the normal output mode for all of my BIOS output functions. This function is used by the DOS character output function calls. The character to be output is contained in the AL register.

AH-15 — Return the current video state. My BIOS returns AL=2 (80 by 25 black and white), AH=80 (number of columns on the screen), and BH=0 (current active page number).

This function becomes a simple character output routine to send data to the terminal. The terminal is interfaced via a serial port, and operates in a polled I/O mode. If the interface isn't ready when this routine is called, it waits until the character can be sent before returning to the calling program.

If you use a different type of console driver (memory mapped video board, for example), you may want to incorporate some of the other features (read screen, etc.) into your interrupt handler.

Simple character output is the only function necessary for operation of PC-DOS.

Interrupt 11 — Equipment Check

This interrupt returns a data word which defines the hardware present in the system.

In the PC this value is determined by reading the switches on the motherboard. Since my system doesn't have these switches, I set this data word in the initialization code. The value is returned from this routine in the AX register.

The meanings of the 16 bits which form the equipment definition are as follows:

Bit 0 — If this bit is 1, it indicates that floppy disk drives are present in the system. If zero, no floppy disks are contained in the system.

Bit 1 — Not used, set to zero.

Bits 3,2 — Indicate the base RAM size. This is a carryover from the original IBM-PC, which could accommodate a maximum of 64K RAM on the motherboard. I don't know if these bits are required by PC-DOS, but it's best to set them to their maximum value of 11, indicating 64K of motherboard RAM. The other values are 00 = 16K, 01 = 32K, and 10 = 48K.

Bits 5,4 — Indicate the initial video mode for the monitor interface. Set to 11 for 80 by 25 black and white. Other values are 00 = not used, 01 = 40 by 25 color graphics card, 10 = 80 by 25 color card.

Bits 7,6 — Indicate number of floppy disk drives (5.25", IBM format) contained in the system. Bit 0 must be one for this parameter to have any meaning. The values are 00 = 1 drive, 01 = 2 drives, 10 = 3 drives, and 11 = 4 drives.

Bit 8 — Not used, set to zero.

Bits 11,10,9 — Indicate the number of RS-232 serial interface cards contained in the system. Do not include the serial interface to the system console.

Bit 12 — Indicates that a game I/O interface is present if set to 1.

Bit 13 — Not used, set to zero.

Bits 15,14 — Number of printer interfaces in the system. This can be misleading, since the IBM BIOS assumes that printers are interfaced via a parallel port (Centronics type interface). If you use a serial interface to the printer set these bits to zero. The DOS MODE command can be used to redirect the printer output to a serial port.

(continued next page)

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Interrupt 12 — Memory Size

This interrupt returns a data word (in the AX register) which indicates the number of contiguous 1K blocks of memory in the system. The maximum RAM supported by the PC is 640K.

Interrupt 13 — Floppy Disk I/O

This interrupt handles all floppy disk I/O requests for 5.25" disks. The function to be performed is contained in the AH register.

All of the functions return information in the carry flag and the AX register. If the carry flag is clear, the operation was successful. In this case, the AH register is returned as zero, and the AL register contains the number of sectors of data transferred by the operation. If an error occurred, the carry flag is set, and AH contains the error code.

The AL register indicates the number of sectors transferred (it may not be the same as the number requested).

Here are the five functions handled by this routine —

AH=0 — Resets the disk system. No physical request need be sent to the disk controller by this command. A memory variable is set indicating the disk status is unknown and a home (seek track zero) operation should be performed by the next read or write. This function should always return with the carry flag clear to indicate successful completion, and zero the AH and AL registers.

AH=1 — Reads the status of the floppy disk system. This function returns the status of the last disk operation in the AL register. The carry flag is set according to the value of the status word returned.

AH=2 — Reads sectors from the floppy disk into memory.

AH=3 — Writes sectors from memory to floppy disk.

AH=4 — Verifies sectors with data in memory. No actual data transfer should occur.

AH=5 — Formats (initializes) the track.

For the read, write, and verify operations, data is passed to the routine in registers in the following manner:

DL — Contains the drive number, 0 through 3.

DH — Contains the head number, 0 or 1.

CH — Contains the track number, 0 through 39.

CL — Contains the sector number, 1 through 9.

AL — Contains the number of consecutive sectors to transfer.

ES — Contains the segment for the data.

BX — Contains the offset for the data.

In other words, ES:BX is the data address.

For the disk format operation, ES:BX points to a table of parameters which supplies information for the format operation.

The table contains the track, head, sector, and sector size code — one entry for each sector to be formatted. This data is for the NEC 765 floppy disk controller chip (standard in the PC and clones). If your system uses this same chip, you can incorporate the format code into the BIOS.

My system has a Tarbell double density disk controller, which uses the Western Digital 1793 controller chip. The 1793 requires completely different data to initialize a disk, and therefore

the format code is not included in the BIOS.

Floppy Disk Controller

I used DMA (Direct Memory Access) to transfer data between the controller and memory. This isn't a requirement, and a programmed I/O controller could just as easily be used. Only the read/write code in the interrupt handler would have to be changed.

Interrupts

The interrupt handler checks each request and returns a bad-command error code if the requested function isn't available. This check must be made since a hard disk controller, for instance, uses additional functions, which are also passed in the AH register.

The BIOS interrupt vector for the floppy disk I/O function is modified by the ROM contained on the hard disk controller card. DOS determines the presence of a hard disk by requesting one of these higher numbered functions. If the BIOS returns a bad command error, it assumes that no hard disk is present in the system, and only accesses the floppy disk drives.

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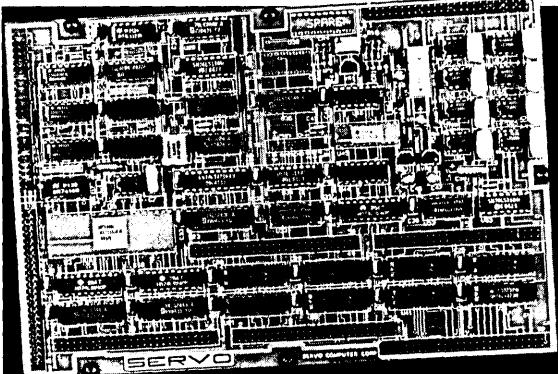
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Disk Accesses

The first function performed by the disk read and write routines is a call to the DMASET routine.

This routine translates the data segment and offset (contained in ES:BX) to a page and offset form. Page refers to a 64K bank of memory, and offset to the location within that page. This is done due to a hardware requirement of the Tarbell and PC disk controller.

The Tarbell controller uses a register to hold the top 8 bits of a 24-bit address for data transfer, with the low 16 bits set by the DMA controller chip.

The top 8 bits are fixed for a single data transfer, so data transfer across a 64K boundary isn't possible. Therefore, after sending the page number (bank) to the controller and saving the offset address, the routine checks to see if the transfer will cross a 64K boundary. If so, the carry flag is set, and the I/O function is terminated with a DMA boundary error.

I haven't determined if this error should be returned if you have a controller which doesn't have this limitation. For example, a programmed I/O controller (like the CompuPro floppy disk controller) could easily transfer

data across a 64K boundary.

Since it's a feature of the PC, I recommend you retain the function and purpose of the DMASET routine, even if it isn't necessary for your controller.

MSETUP

The MSETUP routine in the BIOS listing is configured for a single floppy disk drive, and must be modified for multiple drives.

Only the MSETUP routine is affected by the use of multiple drives. A pause is built into this routine to allow the drive motor to come up to speed, since the Tarbell does not have a means to test the ready condition of 5.25" drives. If your controller polls the drives, the delay can be replaced with a ready test.

Data Transfer

The routine MDAMRW initiates the data transfer by sending commands to the DMA and floppy disk controller. Then after these chips have handled the job, it tests for an error condition.

If an error is found, the error code is translated to the code expected by DOS, and the zero flag is cleared. If

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there's no error, the status parameter is set to zero, and the zero flag indicates no error.

DOS handles all of the retry functions, so there's no retry logic for the seek or read/write routines in the BIOS.

After a successful data transfer (an error would terminate the routine), the read/write code checks for a multiple sector transfer request and transfers additional sectors if needed.

Transferring Multiple Sectors

I have to deal with multiple sector transfers because the 1793 controller chip isn't set up for the type of multiple sector requests issued by DOS.

The 1793 can transfer multiple sectors with a single command, but the ending sector must be the last sector on the track. So multiple sector requests are handled as a series of single sector transfers by the BIOS, transparent to DOS.

If the number of sectors requires reading beyond the end of the current track (as specified by the disk parame-

(continued next page)

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ters, see interrupt 1E), the routine is terminated with a Sector Not Found error.

The common return code for all functions sets the carry flag according to the value of the status word stored by the I/O handlers, and then returns to DOS. An interrupt return instruction can't be used because it would restore the flags to their original condition, and the carry flag would no longer indicate the function status.

The RET 2 instruction throws away the old value of the flags, preserving the carry flag as set by the interrupt handler. The verify command returns the success status.

Format

I set up the format command as a simple (successful) status return. This allows the DOS format command to work properly, assuming the disk has been physically initialized prior to issuing the command.

DOS FORMAT writes the boot record on the disk, initializes the directory, and optionally writes the operating system on the disk.

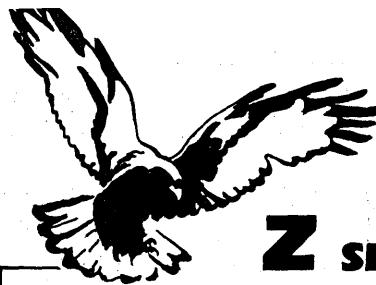
If FORMAT returned an error, it wouldn't be possible to generate a bootable disk with the generic PC-DOS system. So you'll need a separate program to initialize a blank disk (a minor inconvenience). The program I use runs under CP/M, but it could be rewritten for PC-DOS.

If you're using a disk controller with the NEC 765 controller chip (or its equivalent, the Intel 8272 chip), you'll probably be able to use code very similar to that in the IBM BIOS ROM. Except for drive select, motor on, etc., most of the code should work with very little modification. The port addresses will undoubtedly be different, but the commands should be the same.

Interrupt 14 — Communications Port I/O

This interrupt handles all communications with the serial ports. The function to be performed is in the AH register, and the port number is in the DX register.

The port number refers to the IBM communications port number, not the



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physical port address. Port number 0 is the first communications port, 1 is the second, etc.

The functions which are available are:

AH=0 — Initializes the port, returning the full port status in the AX register.

AH=1 — Sends the character in the AL register, returning the line status in the AH register.

AH=2 — Receives the next character in the AL register, waiting until a character is available, and returns the line status in AH.

AH=3 — Returns the full port status in the AX register.

Most of these commands are straightforward, and should present no problems. In my system, the initialize command is ignored, and merely returns the system status. All port initialization is done in the BIOS ini-

talization, prior to booting the system.

The system status consists of data ready bits in the AL register, and the modem status line conditions in the AH register. The data status bits are bit zero set for data ready to receive (test with 01h), and bit 5 for ready to transmit (test with 20h). My BIOS uses bit 5 of the line status register to test DTR, and will not transfer data unless this line is low. This is reversed from some systems, so if your system hangs when you try to do serial output, reverse (or eliminate) this test.

I use the serial ports in my system for the printer and a modem. The serial ports are not required for operation of DOS. If you do not have any serial interfaces in your system this code can be replaced by the dummy return point in the BIOS. If your terminal is interfaced by a serial port, it should not use this interrupt han-

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dler. The communications I/O interrupt should be reserved for use only by additional serial ports in the system.

Interrupt 15 — Cassette I/O

This interrupt is used to interface a cassette tape recorder to the IBM-PC and is not used in my BIOS.

Interrupt 16 — Console Input

This handles all requests for keyboard data from the system. There are three available functions contained in the AH register on entry to this routine —

AH=0 — Reads the next key, waiting until one is available.

AH=1 — Returns the data available status in the Z (zero) flag. If the Z flag is set it means that no data is available. If the Z flag is clear, data is available, and the character is returned. The character read is not destroyed, but will be available for the next read function request. This is often referred to as a non-destructive read operation.

AH=2 — Returns the shift status.

The IBM keyboard is unencoded, and merely puts out a scan code. The ROM BIOS returns the ASCII translation in the AL register, and the raw scan code in the AH register. My terminal outputs ASCII data, and the scan code is always returned as zero. If you want to include the extra code to return the scan codes, it could be done via a look-up table. The scan codes for the keys on the IBM-PC are listed in the IBM hardware technical

reference manual and are simply the numerical codes assigned to each key.

I use an interrupt driven keyboard, but you don't have to. If you use a polled keyboard, make sure you implement the status routine properly so it returns the status without destroying the character (so a subsequent read can retrieve it). This means that the status routine must buffer one character.

Interrupt 17 — Printer Output

This interrupt is for printer output via a Centronics interface. This is the default printer mode for PC-DOS. I did not use this interrupt, but if you need it, the following functions are available:

AH=0 — Prints the character in the AL register. Returns the status in AH. Sets AH to indicate a time out error if the character could not be printed. Sets any other status bits as appropriate.

AH=1 — Initializes the printer port and returns the status in AH.

AH=2 — Returns the printer status in the AH register. The status bits are defined as follows:

Bit 0 — Set for a time out error.

Bit 1 — Not used.

Bit 2 — Not used.

Bit 3 — Set for I/O error.

Bit 4 — Set for printer selected.

Bit 5 — Set for out of paper.

Bit 6 — Set for acknowledge returned from the printer.

Bit 7 — Set for not busy condition.

For all functions the printer number (not the port number) is contained in the DX register on entry to the interrupt handler.

Interrupt 18 — BASIC

This interrupt provides access to the BASIC ROM in the IBM-PC, and is not used by my BIOS.

Interrupt 19 — Bootstrap

This interrupt reads the boot sector (track 0, sector 1) from the disk in the first floppy disk drive. The data is placed at address 0000:7C00 (segment:offset), and if a successful read occurs, the bootstrap program is then executed from that address.

If an error occurs, the program continues looping (forever) until a successful read is accomplished. The disk I/O interrupt (interrupt 13 hex) is used to access the disk I/O routines, so there are no hardware dependent parameters in the boot routine.

You may want to implement an error message after several retries to provide some indication that the system isn't completely hung up. The normal cause for this error would be an unformatted disk, since the boot routine does not check the data which it loads from the boot sector.

Interrupt 1A — Time Of Day

This interrupt either reads the timer counters (AH=0) or sets them (AH=1). Even if you don't have a clock in your system, you should

(continued next page)

(continued from page 59)

preserve this function and the three counter locations used by this routine so the read time function will return the last value stored by the set time function.

Interrupt 1B — Keyboard Break

This interrupt is used by some application programs to handle a keyboard control break input. It should be initialized to point to an interrupt return instruction.

Interrupt 1C — User Timer Function

This interrupt is included in case an application program wants to do something special on each tick of the hardware clock. It's executed every time the clock interrupt handler is entered. It should be initialized to an interrupt return instruction.

Interrupt 1D — Video Parameters

This is not an interrupt but is used as a pointer to parameters for the video card in the PC. This pointer serves no useful purpose in my system, but it should not be used for any other purpose.

Interrupt 1E — Floppy Disk Parameters

This is also a pointer defining the address of the parameters required for operation of the floppy disk.

The pointer is initialized to the data contained in the BIOS, but is modified by PC-DOS to reflect the actual disk format being used.

The floppy disk I/O routines use data from this parameter block to perform the read/write operations. The data contained in the parameter block includes the sector size and the sectors per track, as well as some data unique to the NEC floppy disk controller chip.

Interrupt 1F — Graphics Parameters

This is also a pointer which is used when the IBM video is operating in the graphics mode. It is not used in my BIOS.

Interrupts 40 and 41 — Fixed Disk

These interrupts are reserved for the hard disk controller board which may be used in the PC, and should not be used for any other purpose.

Implementing Generic DOS

Modify the BIOS source code to match your hardware requirements. Pay particular attention to those software interrupt handlers which return information in the flags. These routines must not end with an interrupt return instruction, since that would restore the original state of the flags. Assemble the modified program and correct any errors.

When the code assembles correctly, it's necessary to generate an executable file. This code should be linked to run in high memory, above the memory available to PC-DOS.

After you've generated the executable BIOS file, run it to boot PC-DOS into the system. (With CP/M-86, I type in "PCBIOS," the name of my executable BIOS.)

If all goes well, the BIOS will read the boot sector into memory, and execute it to load the rest of PC-DOS. PC-DOS will request the date and time, and then display the familiar A> prompt on the screen.

Debugging The BIOS

Unless you're exceptionally lucky, the first run won't be perfect. The system will hang up, leaving little indication of the problem. Time for debugging.

Debugging the BIOS isn't as easy as debugging a normal application program since the first thing the BIOS program does is modify all the interrupt vectors. So any normal debugging tools you have, such as DDT86 under CP/M-86, can't be used. Instead we leave messages at the end of the program.

Messages

By including these messages at the entry and exit of the various BIOS interrupts, you can get a good idea of what is going wrong. In the program listing, the message print routines can be enabled for the disk I/O routines by setting the parameter debug13 true. Other messages can be incorporated in a similar manner.

The message print and register dump routines preserve the state of all registers and flags, so they can be used without modifying any of the parameters passed to or returned from the interrupt routines.

Register Dumps

The register dump routine uses memory variables in the BIOS code segment, so if it is incorporated, the BIOS must be in RAM memory. If you're going to put the BIOS in ROM, remove the register dump routine after you've debugged the code.

Proceed logically through the check-out procedure. If you don't enter the interrupt 19 (bootstrap) routine, something is wrong with your BIOS initialization code. If you get to this point, but there is no disk activity, the problem is probably in your disk read logic.

If you get past this point, but there's nothing on the screen, the problem may be in the video output routine. It's possible the initialization of the serial and parallel ports can be causing the problem, but this can be eliminated by using a simple return from interrupt instruction for these two interrupt handlers.

If you get a sign-on message, but there's no response to the keyboard, check your keyboard read routine.

Port Contention

Another potential problem area in some systems is the initialization code contained in the file IBMBIO.COM, which is the first file loaded by the boot routine.

One of the first things this code does is output a value of 20 hex to port number 20 hex. This clears any pending interrupt requests.

If this port number conflicts with any ports on your system and causes undesirable effects, it'll be necessary to patch it out using whatever tools you have available.

The four bytes of code which send this output are B0 20 E6 20 (hex). Change these bytes to NOP instructions (90 hex) to disable the output. The four bytes are located 1975 bytes (decimal) from the beginning of the start of the file. In terms of absolute track and sector number, they begin at byte number 439 of track 1 sector 4 on a single sided PC-DOS 2.1 floppy disk.

There may be other ports in the PC which could cause conflicts with your hardware. The one listed above (port 20H) is the only one I've found which is addressed directly from PC-DOS,

Table 1 - IBM-PC Port Addresses

Port Address	Function
00-0D	8237 DMA controller chip.
20-21	8259 interrupt controller chip.
40-43	8253 timer chip.
60-63	8255 parallel interface chip. Used for keyboard, sense switches, and cassette tape interface.
81-82	DMA page register.
201	Game card.
210-216	Expansion box interface.
278	Printer card #3 base address.
2F8	Serial card #2 base address.
320	Hard disk base address.
378	Printer card #2 base address.
3B4-3BA	6845 video controller chip, BW.
3BC	Printer card #1 base address.
3D4-3DA	6845 video controller chip, color.
3F2-3F5	Floppy disk controller.
3F8	Serial card #1 base address.

rather than via a BIOS interrupt routine.

Table 1 lists the ports I've found on the PC. If you have ports with these same physical addresses, and are experiencing problems, you may want to check for any input or output instructions to these ports.

This isn't easy without some form of debugging tool. If you can get PC-DOS to run at all, you might be able to use the debug program which is part of it. If you're running CP/M-86, and have a way to move files from the PC-DOS disk to one of your CP/M disks, you could use DDT-86 for this purpose.

Many of the port addresses are 16 bits long. If your hardware uses only the low 8 bits for I/O port addressing, the 16-bit addresses could inadvertently address undesirable ports.

Home Free

After you get PC-DOS to successfully boot and sign on, the checkout procedure is almost complete. About the only things you haven't tested are the disk write routines. Try copying some files from one disk to another. If you have the system configured for only one floppy disk, PC-DOS will tell you when to swap disks in the drive

for those operations which require two diskettes.

Restrictions

This system is definitely not the equivalent of a PC. In general, programs which use normal PC-DOS system calls for I/O will run OK. Programs which take advantage of special features of the PC hardware will not. ROM BASIC, of course, will not.

Programs which require graphics capability, such as Flight Simulator, won't run since no graphics capability is included in the BIOS.

Copy protected software probably won't run, since most of the copy protection schemes access the disk controller directly, rather than using DOS (or even BIOS) calls.

I've tested all the general purpose utilities on the PC-DOS system disk — CHKDSK, DEBUG, SORT, etc. They're OK. Many compilers and editors run fine.

Additions?

One useful function would be to set up the terminal function keys to return codes compatible with the IBM keyboard function keys. This would be useful with some DOS functions and some application software.

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Also, some software looks at the scan code returned by the keyboard rather than the ASCII value of the key. By setting up the BIOS to return the proper scan codes, more software may be available for use with the generic system. This function could be implemented with a fairly simple look-up table.

Finally

By taking the software approach implementing PC-DOS, I have achieved some degree of PC compatibility without the expense of new hardware.

I'll probably expand my PC-DOS implementation to include my second 5.25" disk (a 96 tpi drive), my 8" disk drives, and RAM disk.

A nice feature of PC-DOS is that it lets you add device drivers which are loaded when the system boots. So additional devices can be interfaced without changing the BIOS code.

Editor's Note:

Fred's complete BIOS listing can be downloaded from the Micro C Bulletin Board (503 382-7643) or ordered from Fred directly (on disk for \$15).



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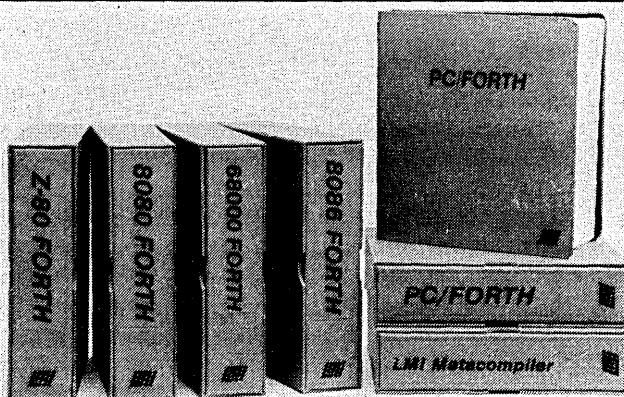
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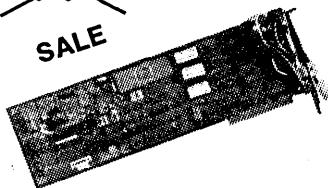
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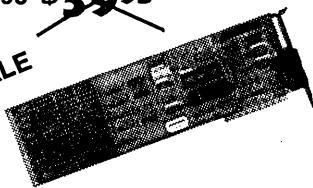
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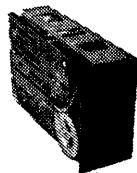


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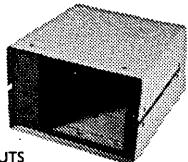
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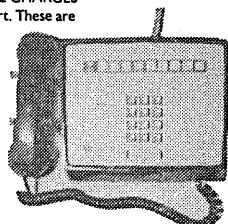
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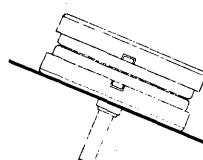
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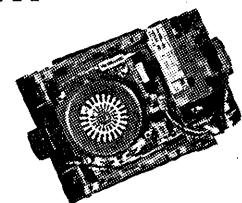
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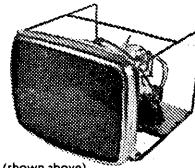


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Writing Pascal-Style Tools For C

There is nothing so dear to the hearts of C programmers as tools. Herein, Ron takes on a few goodies like goto(x,y) and a screen clear. But first he covers direct keyboard input, wives, and mistresses. Fun stuff.

In the last column I discussed some of the dilemmas facing anyone who makes the Hacker's Leap from an implementation of C in CP/M to one running in MS/PC-DOS: buying a compiler, porting your favorite routines over into the 86 universe, facing a whole new gaggle of ways to crash the machine.

This time I'd like to get more down to earth and generate some conveniences that Kaypro-laureates will need once they start slinging useful code on their newer playthings. Even if some of you aren't switching at all, perhaps so far you have shied clear of system-level programming on your PC, and the following short routines may help get you started. The sky's the limit, and there's always the on/off switch to return your system to sanity.

Direct Character Input

If all you want to use in your programs is buffered input from the keyboard (you know — no entry of characters until the carriage return is whacked), standard getchar() will serve your needs, whatever the operating system. But if you're anything like me, writing neat utilities is an addiction; and for that beautiful little utility you dream of showing off to your friends, flashing a response at the touch of a key is an aesthetic fix. For unbuffered input in CP/M, you need to put a simple bdos(1,0) call function into your working library:

```
grabchar() { return bdos(1,0); }
```

If you want to avoid echoing on the screen and if your implementation

provides a BIOS function, a bios(2,0) call will serve nicely instead. Just don't expect ^C and ^S to operate in their normal ways, since you'll be avoiding the CP/M interrupt handlers entirely.

In MS-DOS things get a bit more complicated, in part because that operating system offers many more ropes on which to hang yourself. When MS-DOS was first designed, a good deal of care was taken to give its lowest-numbered BDOS calls the same operations as the comparable functions in CP/M. Thus the listing for grabchar() will transfer as is, though the generic function call name may vary with the implementation. Whatever you call it, it's interrupt 21H, service 1.

To obtain unechoed input, you don't really need to move as close to the bare metal as you must on your Kaypro. Just invoke bdos(8,0): Microsoft tossed in some extra goodies to replace CP/M calls not needed on your clone. Unfortunately, service 8 still won't let you use the function keys (F1...F10, Home, PgUp, etc.) in your programs, since these special keys all return an ASCII null on a simple character call.

Actually, all keystrokes on IBM clones return a word, not a byte. In ordinary text input the high bytes are ignored, but the high byte, called the "scan code," is always there for controlling program flow. If the returned

Figure 1 - grabchar Function

```
#include <regs.h> /* or however your implementation handles */
grabchar()           /* the registers for interrupt calls */
{
    struct rr regs;
    rr.ax=0;           /* service 0 */
    interrupt(0x16,&rr);
    if(rr.ax & 0xff) then return rr.ax & 0xff;
    else switch(rr.ax >> 8){ /*shift scan code to low byte*/
        case 0x53: return 0x1; /*mapping function keys*/
        case 0x54: return 0x2; /*to ^A, ^B, etc.*/
        .....
    }
    ***** and then, somewhere else, the menu: ****
    switch(grabchar()){
        case 'a': ...
        case 'b': ...
        case 0x1: ...
        case 0x2: ...
        .....
    }
}
```

Figure 2 - Service 2

```
gotoxy(row,column)
    int row,column;
{
    struct regs rr;

    rr.ax=0x200;          /*2 into AH */
    rr.bx=0;
    rr.dx=0x100*row+column; /*row into DH, column into DL */
    interrupt(0x10,&rr);
    /* the upper corner is (0,0). If you are a Pascal habitue
    and would like to think of it as (1,1), then use "--row" and
    "--column" in the algorithm above. */
}
```

character is a null, then the program knows that a special function key has been hit, and the task is to examine the high byte to see which function key it is.

There are two ways to examine the high byte. MS-DOS function calls 1, 7, and 8 have been designed so that if the character received is a null, the very next call to that function will return the high byte instead. Thus a menu might be constructed to use the special function keys:

```
switch(bdos(1,0)){
    case 'a': ...
    case 'b': ...
    case 0: switch(bdos(1,0){
        case 0x53: ...
        case 0x54: ...
    }
}
```

and so forth. If you want to avoid echoing — and echoed scan codes from function keys are rather silly, anyhow — use MS-DOS function 8 instead. Good programming practice, of course, suggests that all those fancy system-dependent functions be gath-

ered up into a single function — e.g., grabchar() — to make the next Hacker's Leap a tad easier.

A direct call to interrupt 16 hex will also do the job, though any time you sally forth beyond interrupt 21 you increase the risk that the program won't run on somebody else's machine. But since prudence is scarcely a trait of C programmers, let's charge straight ahead.

Because the interrupt 16H return is a word in the AX register, we'll get the character and scan code in single call. This time I'll use the function keys and with a bit of mapping retain grabchar()'s single-byte output (see Figure 1).

Such mapping becomes feasible, of course, only if (in this case) ^A and ^B (0x1 and 0x2) are not used separately. The benefit gained is system-independent code. I use this trick so the cursor key code will be the same on my MS-DOS programs and on the CP/M programs for my beloved Kaypro.

Only the definition of grabchar() need be altered in moving back and forth between wife and mistress. (Try explaining that to your better halves whichever they may be.)

Screen Control

Everybody who writes menus and needs unbuffered input also needs to control the screen display. Writing for the Kaypro makes screen control a breeze. Want to clear the screen? Embed a "\032" (^Z) in a string, and poof! things are scrubbed up and ready to go. A couple of escape codes take me to the row and column of my choice. Though the ANSI.SYS driver does allow similar games with the IBM screen, it's slow and, besides, that's one more darned thing to fill up the memory with. Using Turbo Pascal has gotten me used to calling "clrscr" and "gotoxy" functions, so let's write our own in C and store them in our working library.

To the rescue comes interrupt 10 hex, the video interrupt. Service 2 (Figure 2) sets the cursor at the desired position.

The inverse of this function uses service 3 shown in Figure 3.

Clearing things is almost as easy. Service 10 lets you write a string of characters to the screen, beginning at the cursor position. Therefore writing blank spaces (ASCII 0x20) clears a portion of the screen. That means one could clear the screen entirely by going to (0,0) and writing 2000 (25*80) blanks, or clear to the end of the screen from the current position, or clear to the end of the line, depending on what number is loaded into the CX or "repeat" register (Figure 4).

Service 10 doesn't change the screen attributes. Service 9 does. If you want to restore the screen after a fling at reverse video or the like, set rr.bx=0xf (or 0x7, if you prefer a dimmer screen) and set rr.ax=0x900 + ' '. Rich folks with color monitors have more complicated choices to make. Obviously, clr() could be written to take another argument or two for fine tuning. With this and the input routines in place, you'll be able to give Peter Norton a run for his money. You just won't get rich and famous doing it at so late a date.

Figure 3 - Service 3

```
curpos()
{
    struct regs rr;

    rr.ax=0x300;
    rr.bx=0;          /*the default screen page */
    interrupt(0x10,&rr);
    return rr.dx;      /* row in high byte, column in low.
                        Add 0x101 to the return if you are
                        playing (1,1) games. */
}
```

Figure 4 - Clear Screen Function

```
clr(c)      /* 's'=screen,'l'=line,'e'=end */
char c;
{
    struct regs rr;           /* storing cursor position */

    cp=curpos();              /*get cursor position */
    x = cp & 0xff;
    y = cp >> 8;
    switch(toupper(c)){
        case 'S': gotoxy(0,0);
            rr.cx=2000;           /* 2000 characters on screen */
            break;
        case 'E': rr.cx=2000-80*y-x; /* 80 chars to the line */
            break;
        case 'L': rr.cx=80-x;
            break;
        default : return;
    }
    rr.ax=0xa00+' ';          /* blank with ASCII 32 string */
    rr.bx=0;                  /*page again */
    interrupt(0x10,&rr);
}
```

(continued next page)

(continued from page 65)

Addendum: A Nice Find

Last time I also grumbled awhile about the problem of getting out of a lock-up without zapping the memory of a compatible. If the dead end routine happens to call one of the MS-DOS function calls, a ^C will often break you back to the operating system with all data intact. If it's a closed arithmetic loop or something more exotic, however, the computer just sits there, and sits there, and sits there — while you bang furiously on everything in sight, sounding all the world like some crazed woodpecker.

Of course, there's always ALT-CTL-DEL, but on IBMs and I don't know how many clones, an ALT-CTL-DEL nulls the memory, making recovery of data from working buffers and RAM disks a task leading to tears and/or strong drink. My Zenith, may the Lord be praised, just leaves the higher memory alone, unless the RAM disk is allowed to re-form itself and eat up

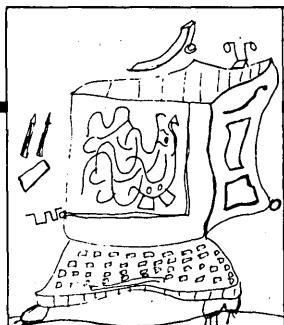
the RAM disk file allocation table information.

Well, I still don't have the full equivalent of the panic button on the back of my Kaypro, but things have gotten better since I started loading a little (i.e. 128 byte) resident program "uncrash.com" offered in a recent issue of PC Magazine. This little gem uses the clock interrupt to snatch control away from the lock up, testing for a control-Break (not a ^C) and popping you back to the operating system if one is detected. Unless the program itself captures the printer interrupt in weird ways (as do some forms of BASIC), you get a chance to bail out 18 times a second. Many hours and not a few boxes of Kleenex saved.

If the entire keyboard interrupt code has been zapped, of course, no banging on the break key (or on ALT-CTL-Break, for that matter) will catch anybody's attention. Then I still dream of jolly red buttons on the back.

Ninety percent of the time, however,

we C programmers have just forgotten to put in the loop test or have written "greater than" when we really meant "less than." Then the clock interrupt escape route surely helps. Try it; you'll like it. The magazine's listing requires BASIC, so if you're really fastidious, give me a call and I'll let you have a copy of my sanitized COM file. At 128 bytes, it transfers somewhat fast via XMODEM.



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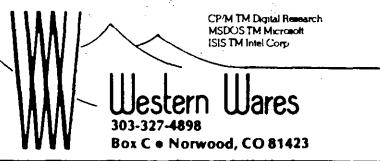
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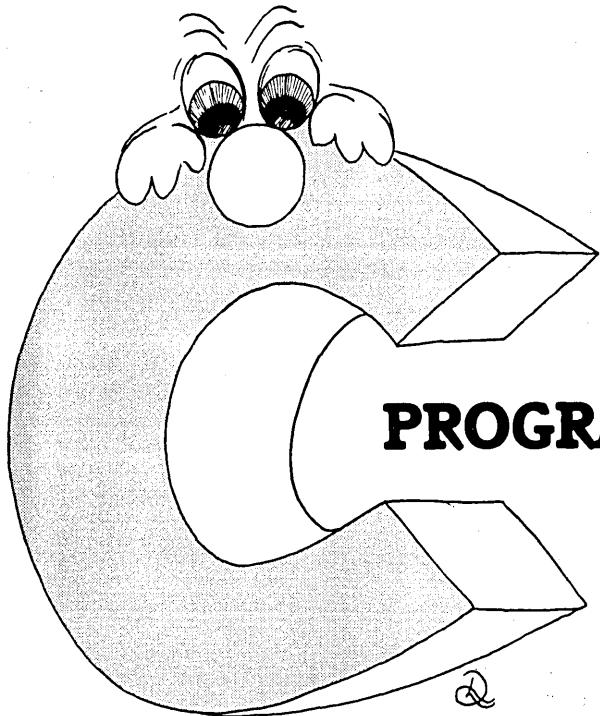
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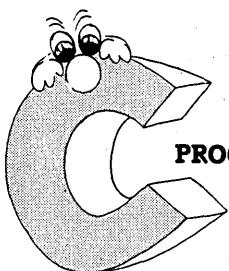
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The Racer's Edge Caching And Floating On The 68020

By Trevor Marshall
(with Sigi Kluger and Chris Jones)

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The DSI-32 introduced a lot of us to the world of power computing. I admit it, even though I'm harassed by my family, prodded by my readers, and ignored by my coworkers — when I strap into my black leather anti-g suit and sit down at my 32032 I have power! Phthththththth!

When it was introduced just a year ago, the 32032 and its companion floating point processor were the fastest things you could hide in a micro. Now, however, there is something faster (surprise). It comes from Motorola and it resides on two newer, faster, but no more expensive, DSI boards.

There is something about designing which says you can't do just one. So, ever since we released our 32032 based DSI-32 we've been looking around for our next product.

With the transputer, the 32332, and a number of other interesting chips either coming down the pipe or already trickling out the end, there were certainly some interesting choices.

However, when we looked at the options — reduced instruction set

(RISC) architectures vs. faster, larger versions of the 32032 and 68000; real silicon vs. expectations; fast math coprocessors and memory management chips (MMUs) vs. little or no support — we chose the 68020 family.

The 68020 is significantly faster than the 32332 (National's latest version of the 32032). The 68020's math chip, which we will discuss shortly, is more powerful than the 32032's. On the other hand, the 68020's MMU chip (really important for multi-user, multitasking environments) is not yet ready for prime time. So there are some trade offs.

Speed

The 68020 is tremendously fast. To understand why, look at the program in Figure 1.

The 68020 has an instruction cache — 64 tags, each holding four bytes of code. These are the most frequently used pieces of your program.

The cache can't store data because external devices (such as DMA) would have difficulty deciding whether the data you just modified was still in cache or in main memory.

When the CPU asks for an instruction, the cache control logic looks for it

in the cache. If it's not there, it reads it into cache, four bytes at a time, from main memory.

Once the code is in the cache it's flushed only when the cache gets full, and then only after all the other less frequently used locations have been replaced.

Consequently, at any one time, code from all over the memory can be in cache, depending on what your program is using. A frequently used subroutine, for instance, may take up permanent residence in the cache.

More Cache

The cache is one of two key reasons the 68020 family is so speedy.

When an instruction is found in cache the 68020 takes only ONE CLOCK CYCLE (80ns at 12.5MHz or 60ns at 16.7MHz) to read it to the (pipelined) execution unit. This contrasts with the four clock cycles (including one wait state) for main memory accesses.

We added a jumper to the DSI-020 so you can turn this cache off.

Photo 1, taken with the cache disabled, shows the bus activity during the loop from MOVIT to the branch, which occurs three instructions later.

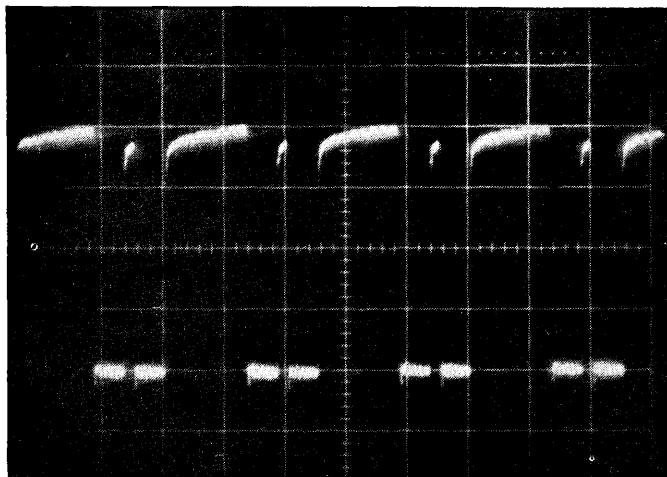


Photo 1 - Cache Off

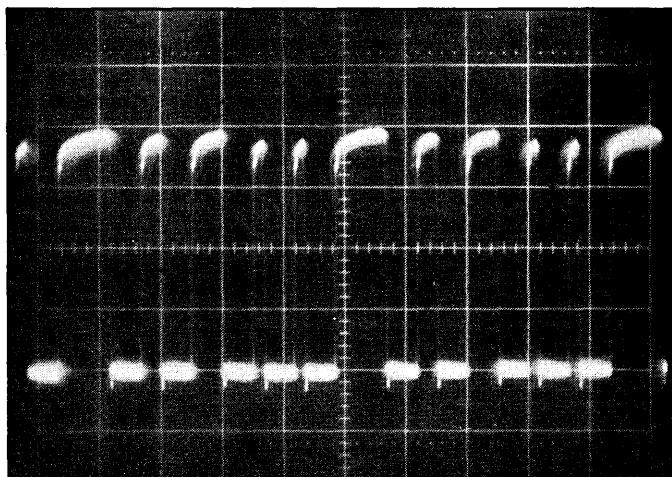


Photo 2 - Cache On

When the (address strobe) signal is low then the CPU is reading from main memory (240ns each time). When it's high the instruction is being processed (80ns plus).

The reference point (after the BRANCH instruction) is followed by the read of the indirect register to register move opcode.

This is followed by the fetch from "A0" and the store to "A1". The SUBQ executes internally very quickly (and so only one clock elapses between the final two accesses).

The scope is set to 500ns per division so the total loop time is approx 2.3us. Photo 2 shows the bus activity when the cache is working. Note that the entire program easily fits within the cache, so only data is fetched from main memory.

The first thing to notice is that the total loop execution time is now only 1.2us. The second thing is that the two data fetches are closer together. This is because the CPU is pipelined internally. Since it doesn't have to go out to the bus to get the opcode, instruction execution is faster.

The 68020 is the first microprocessor with a cache. The cache gives it blinding speed for things like integer operations (2 to 3 times a VAX 11/780) — much faster than the 32032 or the 32332. The Sieve of Eratosthenes takes less than 0.9 seconds on the 16.7MHz 68020. (Editor's note: Makes it kind of hard to time the standard benchmarks, doesn't it?)

Figure 1 - Byte Transfer Program

```
; TEST PROGRAM
; THIS PROGRAM CONTINUOUSLY MOVES 458,752 BYTES FROM
; ONE LOCATION IN MEMORY TO ANOTHER.

; ORG      $00004000

; START: MOVE.L #8000,A0          ; SOURCE ADDRESS
        MOVE.L #80000,A1          ; DESTINATION ADDRESS
        MOVE.L #114688,D0          ; COUNT
LOOP:  MOVEM.L D0/A0/A1,-(A7)    ; PUSH REGISTERS
        MOVIT: MOVE.L (A0)+,(A1)+  ; MOVE 4 BYTES AT A TIME
        SUBQ.L #1,DO              ; DECREMENT COUNTER
        BNE.B   MOVIT             ; LOOP UNTIL DONE
        MOVEM.L (A7)+,D0/A0/A1    ; POP REGISTERS
        BRA.B   LOOP              ; AD NAUSEAM
        END
```

Floating Along

The second difference between the speed of the 32032 family and the 68020 is the 68881 floating point processor. A number of DS1-32 users complained that the 32032 was only 2 or 3 times faster than their AT, not 10 as the benchmarks suggested. The reason is simple. The 32081 floating point unit, although many times faster than the 8087/80287, only performs the primitive + - * / operations.

Functions such as COS, SIN EXP, or LOG have to be performed by a software subroutine. The 8087/80287 has these partially coded in hardware, and thus they execute them more quickly.

The 68881 floating point unit not only performs the basic arithmetic at high speed but also all the commonly used mathematical functions. In addition, they're calculated internally to 80-bit accuracy.

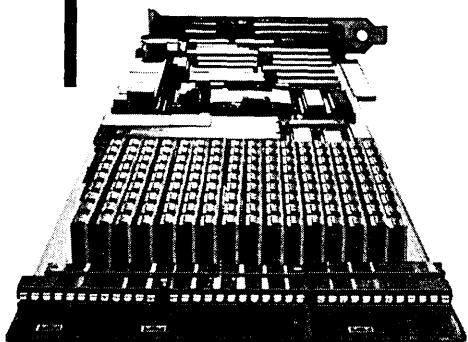
Numbers

The 68020 family does over a million single-precision whetstones. At 1067K, the 16.7MHz DS1-780 is almost as fast as the VAX 11/780 (1152K). IBM's super-fast PC-RT plods along at 200K. (What a delight it is to have that machine as a competitor!)

Since all calculations are performed to 80-bit accuracy, the 68020 easily outpaces the VAX 11/780 on the double precision whetstones (at 902K per second).

(continued next page)

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(continued from page 69)

(The whetstone is a floating-point benchmark written in the late 60s by a fellow named Curnow. Whetstone programs are available in the public domain for CP/M and MS-DOS systems. The program "dhystone" is an integer variation.)

Details

The DSI-020 and DSI-780 both use an IBM-PC/XT/AT as the disk, file, and console I/O system. (Those of you who can't compromise your principles should consider an X16, XT-186, or Challenger XT to use as a base.)

Both DSI boards use an auto-sensing AT/XT bus connector that adjusts to

the 8- or 16-bit bus (with 16 bits you gain 10 percent on disk I/O).

The DSI-020 has 1 Meg of memory (although Micro C will no doubt tell you hackers how to expand it to 2) and a 12.5MHz chipset (only gives 770K whetstones, sorry). You can purchase it, assembled and tested, for the price of the DSI-032 starter kit.

Parity and serial ports are a little extra. The DSI-780 is the up-market product, with a 16.67MHz chipset and 4 Meg of 256K RAM (expandable to 16 Meg of 1 megabit RAMs) on the motherboard. (Editor's note: Hold on there, we just got through discussing how we could make a winchester look like 15 Meg of RAM because no one in their right mind would put 15 Meg of

real RAM into a micro. Would they????)

Compilers

The compilers are from Silicon Valley Software this time. Although a little slower than Green Hills, they are more complete and have much better manuals. (The Pascal even comes with strings!) The FORTRAN is ANSI-F77, not derived from UNIX.

Lattice Logic (of Great Britain) has supplied their ANSI level 1 Pascal and C. The Living Software (also G.B.) BASIC-C converter complements the SVS BASIC interpreter. QUELO supplied a low-cost assembly language development system.

The operating system kernel func-

Figure 2 - Copy Program

```

COPYF IDNT 1,0           ; VERSION 1.0
; THIS SAMPLE PROGRAM COPIES ONE FILE. IT SHOULD BE
; CALLED WITH TWO ARGUMENTS, THE SOURCE AND DESTINATION
; PATHNAMES. FILES MAY BE OF ANY SIZE AND TYPE.
; WRITTEN BY S. KLUGER, DEFINICON SYSTEMS INC.
;
ORG $00004000           ; STANDARD DSI-020 ORIGIN
;
START: MOVE.L 8(A7),DO    ; GET ARGC PASSED ON STACK
MOVE.L 4(A7),AO          ; GET #ARGV PASSED ON STACK
CMP1.W #3,DO             ; MUST BE 2 ARGUMENTS
BNE.W ERRORA
MOVEA AO,A5              ; SAVE #ARGV
MOVE.L #COPY1,A0          ; SAY, "COPYING"
BSR.W PRINTS
MOVE.L 4(A5),AO          ; GET FILENAME PTR INTO AO
BSR.W PRINTS              ; PRINT SOURCE FILENAME
MOVEQ #5,DO               ; OPEN REQUEST
MOVEQ #0,D1               ; READ MODE
TRAP #14
CMP1.W #$FFFF,DO          ; IF FILE NOT FOUND
BEQ.W ERRORI
MOVE.W DO,INHDL
MOVE.L #COPY2,A0          ; SAY, " TO "
BSR.W PRINTS
MOVE.L 8(A5),AO          ; GET DESTINATION FILENAME
BSR.W PRINTS              ; DISPLAY IT
MOVEQ #7,DO               ; CREATE OUTFILE
TRAP #14
CMP1.W #$FFFF,DO          ; ERROR IF CANNOT CREATE
BEQ.W ERRORO
MOVE.W DO,OTHDL
LOOP: MOVE.L #BUFFER,A0   ; POINT TO RAM BUFFER
MOVE.W INHDL,D1            ; GET INPUT FILE HANDLE
MOVEQ #8,DO               ; READ REQUEST
MOVE.L #80000,D2            ; READ UP TO 512K
TRAP #14
TST.L DO                 ; IF WE READ ZERO BYTES
BEQ.W DONE                ; THEN WE MUST BE FINISHED
MOVE.L DO,D2               ; ELSE MOVE ACTUAL BYTE COUNT
MOVE.W OTHDL,D1            ; GET OUTPUT HANDLE
MOVEQ #9,DO               ; DO A WRITE
TRAP #14
BRA.B LOOP                ; NOW GO GET MORE
;
DONE: MOVE.W OTHDL,D1       ; GET OUTPUT FILE HANDLE
MOVEQ #6,DO               ; CLOSE IT
TRAP #14
CLR.W DO
RTS                      ; NOW, BACK TO OPERATING SYSTEM
;
ERRORA: MOVE.L #MERRA,A0
BRA.B ERROR
;
; ERROR HANDLING
; MOVE.L #MERRD,A0
; BRA.B ERROR
; MOVE.L #MERRR,A0
; BRA.B ERROR
; MOVE.L #MERRI,A0
; BRA.B ERROR
; MOVE.L #MERRO,A0
; MOVEQ #1,DO
; MOVEQ #9,D1
; TRAP #14
; CLR.W DO
; RTS
;
; THIS ROUTINE COPIES THE NULL-TERMINATED STRING AT (AO)
; TO "STDOUT" (DISPLAYS IT ON THE SCREEN)
;
PRINTS: MOVE.L AO,-(A7)      ; SAVE STRING POINTER
PSL: TST.B (AO)             ; SEE IF AT END
BEQ.B _X                  ; DONE IF END OF STRING
MOVEQ #1,D1               ; STDOUT = HANDLE 1
MOVEQ #1,D2               ; ONE BYTE ONLY
MOVEQ #9,DO               ; WRITE REQUEST
TRAP #14
ADDQ.L #1,A0               ; POINT TO NEXT BYTE
BRA.B PSL                 ; AND LOOP
;
_X: MOVE.L (A7)+,AO          ; POP STRING POINTER
RTS                        ; RETURN TO CALLER
;
MERRA: DC.W $0DOA
DC.W 'USAGE: LOAD COPYF INFILE OUTFILE'
DC.W '(FULL PATH OK)',$0DOA,'$'
;
MERRD: DC.W $0DOA
DC.W 'ERROR DELETING FILE',$0DOA,'$'
MERRR: DC.W $0DOA
DC.W 'ERROR RENAMING FILE',$0DOA,'$'
MERRI: DC.W $0DOA
DC.W 'ERROR OPENING INPUT FILE',$0DOA,'$'
MERRO: DC.W $0DOA
DC.W 'ERROR CREATING OUTPUT FILE',$0DOA,'$'
;
COPY1: DC.W $0DOA
DC.W 'COPYING ',0
COPY2: DC.W ' TO ',0
;
INHDL: DC.W 0                 ; INPUT FILE HANDLE
OTHDL: DC.W 0                 ; OUTPUT FILE HANDLE
;
BUFFER: DC.B 0                 ; START OF BUFFER
END

```

tions have been expanded and improved, building on our DSI-32 experience. Sigi Kluger has provided a number of new operating system hooks to ease assembly language programming.

Using The 68020

Figure 2 shows a simple program to copy an MS-DOS file to another, using the 68020.

When the program execution begins, the kernel has sized the memory, allocated a stack at the top of it, placed ARGC and a pointer to ARGV on it, and set up a system return address for use at program completion. An RTS (viz, RET) instruction will return to the operating system (MS-DOS) with the value in D0 returned as a program return parameter. This parameter may be conditionally tested in an MS-DOS batch stream.

The operating system is accessed via the TRAP #14 instruction.

The file system uses the MS-DOS (XENIX-like) disk I/O functions to ease the interface to high level languages.

When you OPEN a file, a HANDLE is returned, which is used to identify subsequent accesses to that file. This saves having to point to an opened FCB all the time. The data buffer size is 512K.

This program (on a Taiwanese PC-AT clone) takes 2.47 seconds to copy a 123K file.

Note that the ERROR: subroutine uses a BDOS call (#9, print a string) to output its messages.

Summarizing

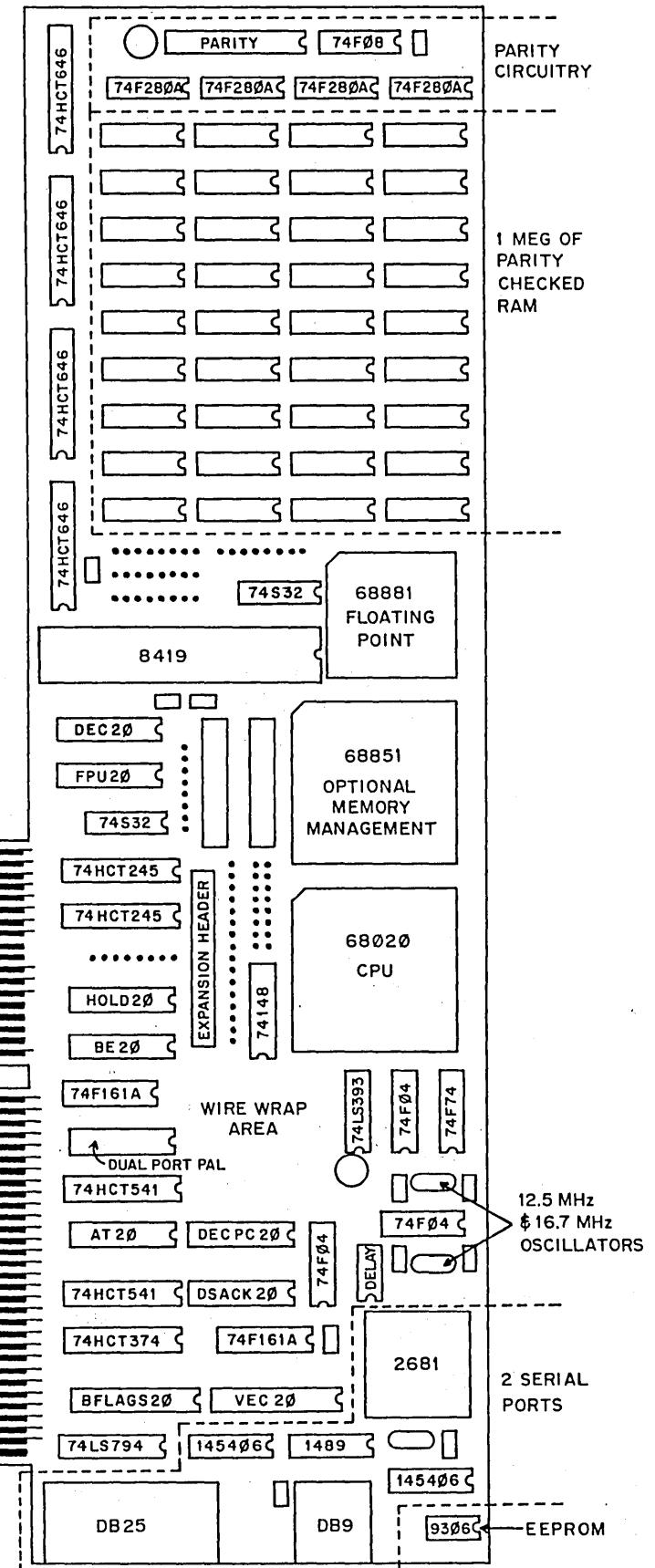
The DSI-020 represents second generation 32-bit technology. The 68020 family represents technology that is unequalled in silicon today.

The 32332, although significantly faster than the 32032, is not as fast as the 68020.

If UNIX is your operating system, then continue to use the National family. Motorola's UNIX is still too expensive and their MMU is not bug free. If absolute performance is your goal, then go for the 68020 — it'll be some time before this family can be beaten.

See you all at SOG.

*Layout of
68020
Co-processor*



Split Personalities

The V Series (20-70) & The 80386

By Dean Klein
904 N 6th St.
Lake City MN 55041

NEC has shown that it can take the latest features of the 80186, add 8088/8086 pin compatibility, an 8080 instruction set, some new instructions, and put it all together in a low-power CMOS package. Super!

However, what about NEC's new V40, V50, V60, and V70? What are they? Are they winners, or is NEC having trouble making product decisions when it's leading instead of following?

Schizocentralprocessingunits. What is it? It's the latest — a family of processors with split personalities, i.e. dual instruction sets.

NEC's family name begins with "V"; the V20 and V30 were the first members. Two are just out — the V40 and V50 (with integrated peripherals much like Intel's 80188 and 80186); and two more are announced — the 32-bit V60 and V70.

Intel's latest baby is also 32-bit, the 80386, and it, too, falls in with this split personality group, designed for compatibility with previous Intel chips.

V20, V30, V40 & V50

The V20 and V30 are pin compatible with the Intel 8088 and 8086. And the V20 and V30 can, in most cases, replace their counterparts.

The V40 and V50 cannot. Although they have integrated peripherals (like the 80188 and 80186), they ARE NOT pin compatible.

All of the NEC V series processors have been built (using the CMOS process) to consume less power and to operate cooler. One undesirable effect of this is a slightly diminished bus drive capability which can cause problems in some PC clone boards.

Improved Microcode

Most CPUs use microcode (a low level translator) to implement machine code instructions.

The execution unit obtains an instruction and decodes it to determine the appropriate set of microcodes to use. Think of this decoding as a breaking down of instructions into classes of instructions.

The microcode then further differentiates the instructions by looking at the various fields within the instructions which specify the instruction operands (e.g. memory location or register type).

Microcode then controls the transfer (and path) of operands from source to destination. For example —

ADD AX,BX

moves the contents of register AX and BX to the ALU where they're added. The results are put (returned) in the AX register.

Intel and NEC saw the faults of the 8088/86 microcode and improved the microcoding in their later chips. The V series and the 80186/188/286 have similar, speedier microcode.

Effective Address Calc

As I mentioned in an earlier Micro C (Issue 27), the effective address calculation has been sped up by dedicated hardware adders. This lets address calculation proceed while an instruction is executed, saving several clock cycles.

New Instructions

The V series and the 80188/80186 share new instructions, except for a few V series goodies like bit manipulation instructions and BCD string functions.

The new bit manipulation instructions allow setting, clearing, and complementing individual bits in registers or memory. These instructions are similar to the Z80 instructions for bit operations. The new mnemonics are:

SET1, CLR1 and NOT1

Two new bit field instructions, INS and EXT, allow bit operations on strings of bits made up of bit fields.

Bit fields are variable length data structures from 1 to 16 bits long. They're pointed to by ES:DI:reg8, where reg8 is any byte register or an immediate value.

The INS (insert) instruction moves data from AX to the destination string. The EXT instruction extracts data from the source bit string and puts it in AX.

The 8086 family is somewhat lacking in the BCD arithmetic department, so NEC added new instructions for operating on BCD strings of 1 to 254 digits or as BCD bytes.

The new ADD4S, SUB4S and CMP4S instructions add, subtract, and compare BCD strings. The pointer to the source string is DS:SI; the pointer to the destination string is ES:DI.

Two BCD rotate instructions are useful for unpacking and packing BCD digits. ROL4 and ROR4 rotate the operand one digit.

The Alternate Instruction Set

In emulation mode the V series processors can execute two complete instruction sets — its own and the 8080's.

Emulation mode is initiated by setting the mode flag in the program status word (also known as the flag register, or PSW). The special instruction, BRKEM, sets the flag.

In 8080 emulation mode the processor registers are used differently —

8080 register Vx0 register	
A	AL
B	CH
C	CL
D	DH
E	DL
H	BH
L	BL
SP*	BP*
PC**	IP**

* Stack pointer

**Instruction pointer

The use of BP as a stack pointer allows the 8080 program to keep a

separate stack (other CPU registers are inaccessible to the program).

When interrupts occur the processor saves the machine state on the main stack and executes the interrupt handler in native (8086) mode.

The 8080 code can also call native mode interrupt handlers by using a special instruction, CALLN. 8080 mode can be abandoned with the RETEM instruction.

Integrated Peripherals

The NEC designers built a winning peripheral set into the V40 and V50, similar to the Intel 80188 and 80186, but superior for most applications.

These peripherals include an 8253/4 compatible timer counter, an 8259A compatible interrupt controller, a serial port similar to the 8251, and a good DMA controller. RAM refresh is also built into the V40 and V50.

The serial port is limited in some applications because it lacks the synchronous modes of the 8251. Another more serious limitation is a shortage of pins, which forces some sharing between peripherals. For example, the serial port Receive Data pin is shared with the DMA Request Input, DRQ3. Similarly, TxD and DACK3 share.

Interestingly, the parts are also offered in packages with more pins, but the designers still didn't separate these signals.

The V40 and V50 DMA controller has four channels, and each channel has its own DRQ and DACK pins, making it superior to the 80188/186's.

The DMA controller is compatible with NEC's existing stand-alone DMAC, the 71071. This controller provides a full 20-bit address (unlike the 8237 used in the PC).

The availability of separate DRQ and DACK lines allows the DMA controller to transfer data directly between the requesting peripheral and memory, rather than first reading the data from the source and then writing it to the destination (80188/186 style). This allows for data transfers up to twice as fast as the 80188/186 DMA.

Applications For The V

The V20 and V30 can directly replace the 8088 and 8086 in most cases, adding a substantial boost in speed. A side benefit is the enhanced instruc-

tion set as well as 8080 emulation mode.

However, the V40 cannot replace any existing processor. Its saving grace is that its chip peripherals are similar to those in an IBM PC. The interrupt controller is identical to the PC's as well as the timer counter. The DMA controller and serial port aren't compatible.

The addresses of the V40 on-chip peripherals can be programmed to match the PC's. The base address of the peripherals is set to a 256-byte block by writing to an internal CPU register. The offset of each peripheral is then set by writing to a register for each device.

The DMA controller can be used to provide enhanced functions such as SCSI and networking, functions which aren't found in the standard IBM PC.

I must admit I was really excited after reading the V30 data sheet (just ask my wife). I thought, "If the V30 is this close to being 'just right,' the V40 must be perfect." Then NEC let me down — the peripherals aren't really integrated; they're external to the chip.

The big difference is that the V30 (and the IBM PC) uses address line A0 to access peripheral registers. The V40 starts with A1.

Recall that the V40 bus is 16-bit and the V30's is 8. This slight difference means no integrated peripherals can be used to replace those in a PC compatible design.

Despite it all, the V40 is still superior to the 80186. But would I use it? Probably not, unless 8080 mode becomes an absolute requirement.

While the V40 is built only by NEC, the 80186 has several manufacturers, which helps drive the price down. And there's a lawsuit pending against NEC. Intel's charging that NEC has copied their microcode in the V series.

The 80386

Intel's late entry into the 32-bit CPU arena is the 80386, which maintains compatibility with the 8086 while adding many features, new instructions, new registers, and an improved memory management scheme.

The 80386 operates in either of three modes — Real Address, Protected Virtual Address, and Virtual 86.

In Real Address mode the 80386 looks like an 8086 to the program, except for several new instructions and two new segment registers. The total address space in this mode is 1M bytes (same as in the 8086).

The new 80386 instructions are dedicated to bit manipulation. The BT instruction tests a bit; BTS tests and sets a bit; BTR tests and resets a bit; and BTC tests and complements a bit.

In addition, even enormous bit strings of up to 4G bits long may be defined and manipulated. IBTS inserts a bit string; XBTS extracts a bit string; BSF scans a bit string; and BSR scans it in reverse.

The bit instructions are useful for bit-mapped graphics operations.

When the 80386 is reset the processor automatically performs extensive on-chip diagnostics which test as much as 85 percent of the chip. The results are returned as the contents of the processor registers and can be tested by the boot program.

80386 Real Address Mode

After reset the 80386 is in Real Address mode. All registers are 16 bits long, as in the 8086. The bus width can be 16 or 32 bits wide and selected on a cycle by cycle basis.

The Bus Interface portion of the 80386 checks an input, BS16, late in the bus cycle to determine if the operation run on the upper half of the data bus needs to be run again. This signal can be permanently strapped to either bus size as well.

80386 Protected Address Mode

The 80386 and 80286 Protected modes are compatible, with up to four privilege levels of protection for different tasks (such as operating systems and application programs).

Two restrictions which plagued earlier Intel 16-bit CPUs may be removed in protected mode: program size and segment size.

Since protected mode is a virtual memory mode, the program size can be as much as 64 Terabytes (virtually infinite). The physical address space is 4G bytes, and the segment size may be set up to 4G bytes as well.

(continued next page)

(continued from page 73)

The split personality of the 80386 is subtle and can only be found in protected mode.

The architects of the 80386 wanted their CPU to be upwards compatible with the 80286 and true 32-bit. So they created a 'D' bit flag in a processor register to tell the processor its operand size default.

If D=0, the registers and operands default to 16 bits (like the 80286). To override this default width use an instruction prefix.

For 32-bit mode, set the D bit. This happens when the CPU switches tasks, and a new Code Segment Descriptor is loaded.

In 32-bit mode there are 8 new registers — EAX, EBX, ECX, EDX, ESI, EDI, EBP, and ESP.

In the 80386 assembly language a WORD is still 16 bits and a DWORD is 32 bits, making the transition from 80286 assembly language almost painless.

In protected mode the 80386 can calculate the effective address either from 16-bit components or from 32-bit components. The default again is supplied by the D bit.

An example of effective address calculation would be an instruction which calculates the offset of an array element using a CPU register as a pointer. The default effective address size can be overridden either way by the Effective Address Size Prefix to an instruction.

This system of having default operand and EA sizes is very flexible and allows each CPU task to default to the appropriate condition. The availability of an easy override further enhances the system.

VIRTUAL MODE 86

The major obstacle to the acceptance of the 80286 protected mode has been that once protected mode is entered, the usage of the segment registers changes sufficiently that the CPU can no longer run most programs written to run in Real mode. Thus the IBM PC/AT isn't allowed to operate at peak efficiency for multi-tasking. The 80386's Virtual Mode 86 (VM86) addresses this problem.

In VM86 the processor behaves just

as in Real Address mode except that the Memory Management Unit manages program addresses.

The program still sees a logical address space of 1M. The actual physical address isn't important. The operating system can have several VM86 tasks in memory simultaneously and switch between them and 32-bit applications at will.

Several types of instructions are trapped when executing in VM86 mode. All input and output instructions and any instructions which attempt to affect the interrupt mask flag can be trapped. Software interrupts and instructions relating to protected mode operation, too, can be trapped. Trapped instructions are summarized below:

```
INS, IN, OUTS, OUT    ;optionally  
                      ;trapped if  
                      ;IOPL<3  
  
STI, CLI, PUSHF, POPF, IRET, INT n
```

IOPL is the task's IO Privilege Level and is set by the operating system when the VM86 task is entered.

80386 MEMORY PAGING

Demand paged virtual memory is implemented in the 80386 CPU as an optional extension of the 80286 memory management scheme.

The page size is fixed at 4K bytes. Paging is designed to be managed by the operating system. Each page has several flags associated with it that tell the operating system whether it is a candidate for swapping out or rewrite.

A page has an Accessed flag that tells the processor the page has been read or written. By periodically reset-

ting this bit the OS can determine whether or not the page has been used recently. If not, the page is a good candidate for freeing, since pages that haven't been used recently are less likely to be used in the near future. The page also has a Dirty Flag which tells the OS the page has been written to and must be saved.

To speed the paging operations the page table entries for the most recently accessed pages are cached by the processor in a special Translation Lookaside Buffer. Additional page table entries are stored in memory. If a task attempts to access a page which isn't present, an exception occurs which allows the operating system to get the missing page.

80386 APPLICATIONS

The 80386 will likely find a home in many PC/AT type designs. In the simplest of these, the bus size can be strapped as 16 bits, making the 80386 a drop-in replacement for the 80286 (not pin compatible, however).

With a good design, these PC/AT types should be up to three times faster than the IBM PC/AT, since the initial processor speed offered from Intel is 12.5MHz to 16MHz.

The true power of the 80386 won't be released until a good operating system is written to support it. That operating system might even run PC-DOS as a VM86 task.

Less dependence on hardware compatibility with older machines might allow a high performance workstation to be built which could take advantage of many already available higher performance peripherals. These include DMA, video and disk controllers,

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communication devices, and parallel processors, all better than currently used devices.

Fast multi-tasking with a high resolution video system and windowing sound good to me. I'd like to be able to fly Flight Simulator in one window while I'm working in several others. (Editor's note: Make sure one of those other windows has a good autopilot or you might crash the system.)

The V60 & V70

Yes, there's more. NEC has announced two new 32-bit processors to compete with the 80286 and 80386. The native mode instruction set isn't compatible with the 8086, however. And it probably isn't compatible with the 80386 either. Compatibility with the 8086 is provided by leaving 32-bit mode and entering what NEC calls Emulation Mode. It isn't clear whether there's 8080 emulation.

One interesting feature of these processors is on-chip floating point support. This has the advantages of minimizing the support circuitry required and standardizing the program interface, but has the disadvantages of poorer performance, lower precision and fewer operations.

The V60 and V70 don't have dynamic bus sizing (like the 80386). Instead the V60 has a fixed 16-bit bus, and the V70 has a fixed 32-bit bus.

V60 & V70 Applications

The success of these processors is probably going to be inversely proportional to the success of a good operating system for the 80386. It isn't clear whether these processors have the important 80386 VM86-like mode.

One possible application might be as a graphics engine where the on-chip floating point and bit manipulation instructions could be effectively used for graphics operations. We'll have to wait for more details in order to reach a verdict.

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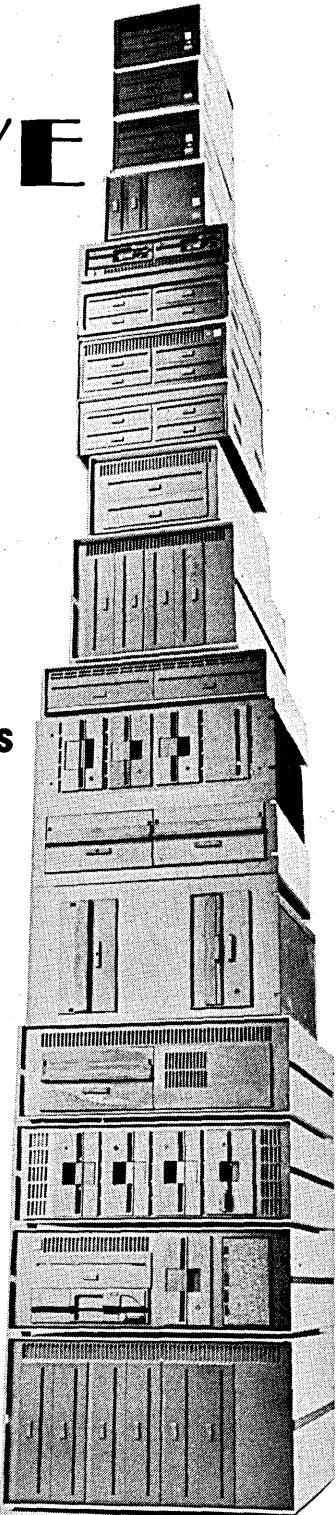


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Puzzles Part II

In Issue 29 we posed the problem: "Two boys were having their purchases totalled at a cash register when the first boy noticed that the checker was hitting the times button rather than the plus. When he commented to the second boy, his friend told him not to worry, the total would come out the same either way."

"They purchased four items. They paid \$7.11. What was the price of each item? Is there only one solution?"

We were inundated with answers. Despite readers' pleas that we accept a less than precise total ("after all, there's sales tax and such" they mumbled) and the fact cash registers don't deal very well with numbers more than two places to the right of the decimal point, there was only one correct answer. In this solution, both the sum and the product of the four numbers totalled exactly \$7.11.

Solutions came in a variety of languages — Assembler, SBASIC and MBASIC, Turbo Pascal, and C — but the method was the same in all — primes.

(Editor's note: Hey, hold on a blinkin' minute. I didn't use primes. I used brute force: floating points and co-processors thrashing about in gigantic loops, and I got the right answer too! Of course mine wasn't as fast in C on the 32032 as the following 16-line BASIC program was on a Z80... But then I learned some pretty interesting stuff about floating point processors. See the editorial.)

A Prime Example

Tom Wilheit from Crofton, MD was among those who submitted the right answer. Here's how he does it:

First, he defines the problem: find four integers whose sum is 711 and whose product is 711×10^6 . Then he factors the product and finds that it may be expressed as $79 \times (2^6) \times (3^2) \times (5^6)$. The problem becomes arranging these 15 prime factors into four terms which add up to 711.

If the value of any term is N, then the sum of the remaining terms must be equal to or greater than

$3x(711x(10^6)/N)^{(1/3)}$. Using this, some simple computations will show that all the terms must be in the range 75-319. One of these terms must contain the largest prime: 79. In order that the term remain in the permitted range it can be multiplied by 1,2,3, or 4. At least one of these remaining three terms must have at least two factors of 5 (i.e. 25). The resulting 25 can be multiplied by any integer from 3 to 12 and stay in the permitted range. Tom eliminates 7 and 11 because they are not in the list of available prime factors.

Thus he is able to specify four possibilities for the first two terms. If two terms are specified then he knows the sum and product of the last two terms; and they can be solved for directly. Thus by direct calculation, he can test these 32 possibilities.

Tom's simple but elegant program in MBASIC runs in about three seconds and shows the correct solution of \$3.16, \$1.50, \$1.25, \$1.20.

One Good Answer Deserves Another

At press time, we'd received the right solution from the following people:

Tom Wilheit, Crofton, MD
 David Barbour, Berkeley, CA
 Michael Salmon, Australia
 Stephen Roe, Albany, CA
 Donald Sengpiel, Round Hill, VA
 Don Brittain, Port Jeff. Sta., NY
 Richard Levine, San Diego, CA
 Henry King, Hyattsville, MD
 John M. Smith, Torrance, CA
 Greg Hall, Woodinville, WA

Even the wrong answers were interesting, if only for a good laugh. The following solution from Gene Austin of Pinehurst, ID is worth printing:

"I think the answer is the cube root of 4 + sales tax. My thoughts are as follows: $X^4=4*X$ THEN $X^4-4*X=0$ AND $X*(X^3-4)=0$ OR $X^3=4$ AND $X=\text{CUBE ROOT } (4)$ but this then would involve a sales tax of 12%. Pretty high, even for Washington!"

Tom Wilheit's MBASIC Program

```

10 FOR M=1 TO 4
20 FOR N=3 TO 12
30 IF N=7 THEN 150
40 IF N=11 THEN 150
50 F1=79*M
60 F2=25*N
70 PROD=(711/F1)*(400001/N)
80 SUM=711-F1-F2
90 DISC=SUM*SUM-4*PROD
100 IF DISC < 0 THEN 150
110 DISC=SQR(DISC)
120 F3=(SUM+DISC)/2
130 F4=(SUM-DISC)/2
140 PRINT F1,F2,F3,F4
150 NEXT N
160 NEXT M

```

Same Puzzle, New Twist

Several readers begged us not to put too many puzzles in The Culture Corner, since they felt compelled to solve them. But tax season is over and vacation is about to begin, so what the heck — here's another:

John M. Smith (above) of Torrance, CA asks: What is the smallest total amount the boys could have spent but still have purchased four items whose sum and product were equal?

SOG Tryout

Since Oregon has no sales tax, you can try out your solution at SOG. You'll be far from home in case something goes wrong:

"That's right, I want you to multiply these four items instead of adding them."

"No, I'm not going to ask you to break a fifty."

"No. No really, you don't have to call the manager."

Anyway

Send in your answers right away, and we'll print them in Issue #31 (we'll have copies of #31 at SOG). And speaking of SOG, bring your brain teasers so we'll have fresh fodder for future Culture Corners.



By David Thompson

Weird Projections & Artificial Intelligence

I hate to admit it but after the last "On Your Own," this column is almost mundane. "86 World" grabbed the baton this issue on importing your own systems and I'm really excited about all the AI articles.

In fact, you could think of this entire issue as a sort of "On Your Own." If you're looking for something with immediate commercial value, look no further than AI.

A couple of months ago a quick-printed, computer output, pamphlet called "Computer Industry Abstracts" (CIA!) showed up on my desk.

Paper-clipped to the front was a letter which began "Attention: David J. Thompson, Editor."

Taking that to mean me, I read further. "Abstracts are mailed quarterly for an annual subscription of \$195." One of the sheets was askew (a sloppy foreign agent perhaps?). I looked it over carefully before sliding it back into place.

Obviously this was no cheap publication (despite appearances) so I had to check it out. It was covered with numbers — plain, unadorned, dry, lifeless numbers. And worse yet, the numbers were projections pirated from such radical hacker rags as Computer Systems News, Datamation, Infoworld, Fortune Magazine and Business Week.

Projections

Let me give you some numbers as reported by CIA.

The sales projections shown in Figure 1 were reportedly made by Computer Merchandising and Computer-World during Oct. 1985.

I don't know if any of these numbers can be real, but they can't all be. So if projections differ that wildly when the year's almost over I

wouldn't put much credence in their stabs at 1986.

However, numbers do tell you what the writer guesses will happen. When the numbers go up, the writer is saying he's excited about that area, and vice versa. (See Figure 2).

Flies In The Projections

Before you start spending the millions you're going to make selling Ada programs to the Defense Dept., let me point out something.

The computer industry was trucking along on these kinds of projections a year ago when suddenly the market went south (it was a cool spring). Hardware manufacturers discovered that computers in the warehouse don't equal dollars in the pocket and software folks found out that those same lonesome computers don't buy software.

Oh, the market didn't go away exactly, it just stopped growing, and believers in all those super growth numbers found out that their numbers were really just that, numbers.

AI

Another problem with projections is that the projectors (projectionists?) appear to have the old NMOS crystal balls.

Look at the AI projections. I think they're way, way low. It's obvious to me that AI will be the next spreadsheet, so to speak. LANs, communications talkers, accounting calculators, database finders, graphics scribblers, music generators, even compilers and assemblers will contain bits and pieces from AI.

What if your accounting package understood what was going on in your business? What if it contained the expertise of a CPA?

What if your modem package could log onto Compuserve at 2 a.m., check for messages, leave messages, and then log off? Perhaps it could also get

into a stock database, search for information significant to companies you're currently holding and have a summation ready by breakfast (and it might add suggestions for new purchases).

What if a music package could digitize sounds, analyze the uniqueness of a sound or song, modify it based on its "experience" with other songs or sounds and then play this new creation?

If a song springs full-blown to mind you could just hum a few bars, tell the package which instruments you wanted and presto. Show that to your kids. Do you think they'd go back to driving a turtle around the screen? Do you think composers would still be scratching little round dots on blank staves? (But then people are still writing books on ancient Royals.)

Programming

But you don't have to come up with a new "spreadsheet" to take advantage of the AI movement. There is already substantial demand from business and industry for people who can take expertise and put it into a computer. AI appears to be the best meal ticket available at this time.

Anyway, use the above numbers as you wish. But if anyone tells you there are no longer any opportunities for individuals in the computer business he'll only be displaying his own (artificial) intelligence.



Figure 1 - Contrasting Sales Figures & Projections (in \$Millions)

Computer Merchandising		ComputerWorld		
	1985	1986	1985	
IBM AT	1,690	3,180	94	342
AT Clones	490	1,570	292	568

Figure 2 - Retail Sales Projections & Totals For 1984 through 1990 (in \$Millions)

	1984	1985	1986	1987	1990
HARDWARE					
Personal Computers (all)		2,500			9,000
Desktop publishing hardware			230		1,000
Process Control Systems		111			2,090
Local Area Network Hrdware	250				4,600
Modems	540	760	1,000	1,300	2,400
SOFTWARE					
All IBM Software	3,200	4,300	5,800		19,500
Ada (Defense Dept)			850		15,000
AI Software (PC)	30	65	130	230	
Self improvement software		75	100	133	317
PC Accounting Software		1,400		2,300	3,800
Micro to Mainframe link soft.	72	130	233	420	
Data Communications soft.	40				360
Networking software	13				500
TOTAL					
All micros, Hard. + Soft.	14,000	22,000	26,000	34,000	58,000

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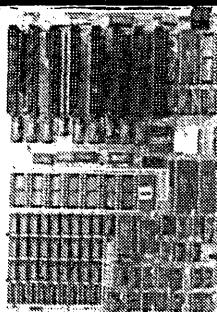
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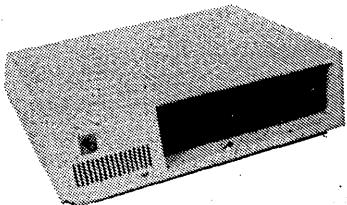
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PC Games & A Z80 Emulator

By Stephen M. Leon

200 Winston Drive
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Steve receives a commercial, copy protected word processor, and guess what? The same program is available in the public domain. But, the big news this time is the Z80 emulator that runs on the 8088. You can run Z80 Turbo on a PC — slowly, but surely.

A computer magazine arrived at my house recently with a relatively new innovation in software distribution — a program disk sealed in light cardboard bound into the magazine. The gimmick was that the copy protection scheme allowed you to run the program a limited number of times. For something like \$70 they would give you the unlocking key.

It was a word processor, but having just updated to NewWord3 (a phenomenal improvement over both WordStar and the old NewWord), and being inherently cheap, I was more interested in the free floppy than the program. However, we ran it just to see what it was like — and it seemed to have a familiar face!

It appears that this same word processing program without copy protection is in the PC/Blue library as shareware. The same holds true with many other programs both in the DOS and CP/M worlds. There are lots of things for free that are equal to, better than, and in some cases identical to, commercial products.

Z80 Emulation On The PC

I still use my TRS-80 Model 1 to check some of the Z80 contributions to SIG/M. However, thanks to Joan Riff of Computerwise Consulting Services, I may be able to finally send the Model 1 to its long earned rest. Joan has written and donated to the public domain Z80MU (PC/Blue 185). The title of her documentation says it all: "Z80 and CP/M 2.2 Emulator User's

Guide for The Care and Feeding of Your Imaginary Z80, or Fakeware For the Techie Masses!"

There I was — no V20 chip, but running Turbo Pascal Z80 CP/M programs on the PC. Sure they could have run faster (Joan is working on that). Sure some of the screen display needed reworking, etc. However, this disk is a significant contribution to the public domain (this is not a "send me money program"). It comes with source code, a good manual, and it works! What more can you ask?

Drivers, SYSLIB, Etc.

I suspect that Micro C probably has a higher percentage of the CP/M-86 and Concurrent CP/M users than any other magazine. For those of you in that category, we have four new "must" volumes in the SIG/M library.

DRI recently sent over their GSX drivers, and we released them as volumes 257 to 260. There are too

many useful modules on these disks to go into detail. Suffice it to say, for anyone doing assembly language programming in CP/M-86 or Concurrent, you must get these disks.

For CP/M-80 assembly language programmers, Rich Conn has done it again. We now have "grandson of SYSLIB." The updated SYSLIB 3.6 Library of Routines is available on SIG/M volumes 261 to 264. Take this as a hint that an update to ZCPR is due out shortly.

Another recent addition to the SIG/M library is an implementation of the IEEE 855 (MOSI) interface by Professor James D. Mooney of the Department of Statistics & Computer Science at West Virginia University. MOSI stands for Microprocessor Operating System Interface and is independent of the programming language. The programs on SIG/M Volume 253 contain an interface for CP/M 2.2 and for Pascal MT+ together with comprehensive

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documentation designed to whet the appetite of the user into additional implementations for other languages and systems.

Our friend from Mexico, Professor Harold McIntosh, has come up with an update to his multi-column printing disk. SIG/M Volume 254 lets you print up to four columns and four files on one or two sides of a page. As is usual with the good professor, code is provided in both CP/M-80 and 86.

We haven't seen a great rush to CP/M 68K. SIG/M Volume 256 contains two utilities (file compare and query erase), but we're always looking for more. On the same disk is a program to transfer files between MS-DOS and CP/M in Turbo Pascal. A program of interest to Kaypro owners is a dynamic trace disassembler on Volume 252. However, it works only on older models with the non-graphic screen.

News From PC/Blue

New and worth mentioning from PC/Blue is DISKIT, a disk repair utility on Volume 176. On 178 we have the PC MAGAZINE benchmark test series. Volume 181 has PC-Kat, a diskette cataloguer. On 182 we have Cut/Paste and Notepad, memory resident utilities like Sidekick. A new version of PROLOG is on PC/Blue 183.

There certainly is no shortage of word processing programs in the PC/Blue library. Working our way backwards through the catalog, on 185 is NYWord. On 182 we have Freeword. A scientific notation word processor (ChiWriter) is on 173. PC-Write version 2.55 (a much acclaimed word processor) is on 167 (version 2.4 is on 130). Volume 95 contains a word processing program for children. The MS-DOS version of ROFF is on 86. There are a few more, but I think the message is clear. If you need a word processor for your PC, you certainly should be able to find it in the library.

Games

Got a note the other day from someone complaining that we rarely mention games. The PC/Blue library does have games. However, I have to ask — when is a game not a game, but rather an insult? Take for example Naval War Simulator on PC/Blue 178. I know Hank Kee is one of those people you can find on the job at almost any hour day or night. On this one, I think he may have been sound asleep when he let it by.

I won't give a nickel to "ask for money" software unless the program is something I find of such value that I would go out and buy it as a commer-

cial product (for example, Tommy Retting's dGENERATE). Naval War Simulator is a sample game — hence a simulated game — that has the audacity to ask for a \$5 donation if you like the sample. Then it pitches you to buy the "enhanced version." This kind of garbage belongs in a waste basket, not in a library or on a bulletin board.

As a saving grace, Henry also included on 178 CaveQuest, a dungeons and dragons game. CaveQuest is well worth getting. What I suggest you do is get volume 178 and send a nasty note to Shadow Mountain Software after you erase NWS.

Other games in the PC/Blue library include: Twenty miscellaneous games on 153 and thirty more on 147. If you want more, Spacewar is on 128, and four other game programs are on 102. A three volume multi-user SuperTrek is on 90-92. Twenty-one other games (including Chess, Eliza, Othello, PCPONG, etc.) are on Volume 25. Volume 24 has another 19 games, including Blackjack, Cribbage, Slot Machine, etc. Most games require a color monitor. SuperTrek requires an 8087.

Computer Hobbyist Of The Year

The Computer Hobbyist of the Year Award is presented at the Trenton Computer Festival to the individual who has made an outstanding contribution to amateur personal computing. It is, in effect, the "Oscar" of amateur personal computing.

The nominees for the 1986 award were William Bolton of New South Wales, Australia, Jud Newell of Toronto, Canada, Irvin M. Hoff of Los Altos Hills, California, and Sol Libes of Mountainside, New Jersey.

Bolton was cited for his efforts to bring amateur computing to Australia and New Zealand through his pioneering efforts in setting up bulletin board systems, acting as a distributor of public domain software, and contributing a vast number of original programs and translations to the public domain.

Newell was nominated for his contributions to the development of amateur computing and bulletin board operations in Canada as well as for his efforts in implementing the Canadian

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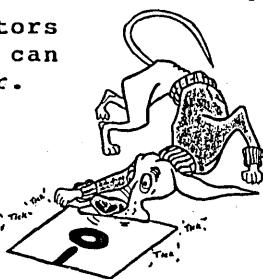
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Jerry Pournelle,
BYTE, Sept '83

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(continued from page 83)

distribution of public domain software.

Hoff was cited for his work upgrading Christenson's MODEM into the MDM series and IMP. He was further cited for his assistance to newcomers to computing via Compuserve.

Libes was nominated for service over an 11-year period in promoting personal computing as a founding member of the Amateur Computer Group of New Jersey, editor of Microsystems and Microsystems/Journal, and author of numerous books on computing and electronics.

The 1986 winner was Sol Libes.

Joining The Public Domain Parade

There is no shortage of contributors to both the SIG/M and the PC/Blue libraries. I must have about 30 volumes of material that I have yet to review for new releases for SIG/M, and new material comes in every week. (Henry Kee, PC/Blue disk editor, probably has a bigger backlog. He

even gets nasty calls on why the material isn't yet out. However, most of his releases ask for donations, hence the impatience.)

Making a donation to your colleagues in computing is not that hard. All you do is fill in the donation form (found on most library disks) and send the disk to either SIG/M or PC/Blue. The SIG/M donation form differs slightly from the PC/Blue form in that we ask you to state that the program does not contain a request for money. PC/Blue allows shareware.

SIG/M disks also usually contain source code. Not so with PC/Blue, although as mentioned before, Joan Riff's Z80 emulator not only contains source code, but it also is a true public domain program. There are many other such contributions in the PC/Blue library, and yours truly would personally prefer to see less shareware and more true contributions there.

If you make a donation to SIG/M and we publish it, we give you your choice of two free library disks. You may want to check this out with your

accountant, but if you developed software for commercial purposes and have a cost basis on it, you might be able to get a tax deduction out of the contribution. (I would suspect, however, that if your commercial sales have reached the point where you are giving it away, you are in a loss position.)

So why not share that software with the rest of us, and support public domain software with a contribution.

5" Disk Formats On SIG/M

While SIG/M has traditionally distributed programs only on 8" SSSD disks, we have for some time recognized the need for 5" distribution. Thanks to a Maynard disk controller and Uniform on a PC, we are experimenting with distributing 5" disks. (We still prefer that you get your volumes locally or via BBS systems). The charge for 5" disks is \$7 per volume. However, for SSSD formats, or any format which requires more than one disk, please add another \$2 per volume.

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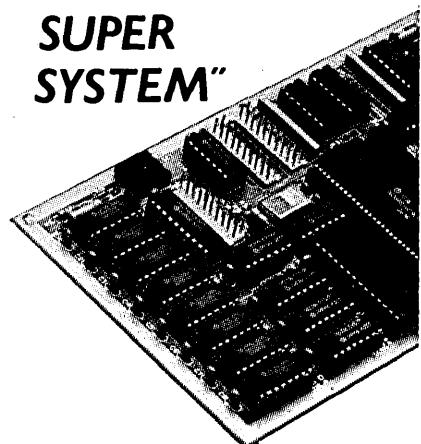
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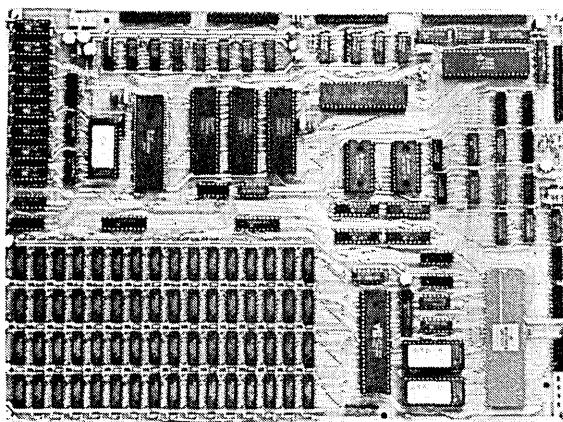
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ICM's S-100 Boards

Dave reviews ICM's single board Z80 processors and slaves. It's obvious that in the S-100 world, the Z80 is still alive and processing.

This column is the second in a series of mini-reviews of Turbo-Dos-capable S-100 hardware. Along with the usual S-100 tips, circuits, and reader feedback, future columns will include a brief look at the offerings of each manufacturer of S-100-based TurboDos products.

Intercontinental Micro Systems

Intercontinental Micro Systems' product list is like a supermarket for S-100 shoppers. Besides offering their own S-100 product line, they also have bought the rights to MUSYS Corporation's S-100 bus boards. In fact, ICM has more S-100 products than I can mention in a single mini-review, so their name will probably crop up in future columns. For now, I'll just cover most of the single-board computer products.

8-Bit SBCs

I'll start with the 8-bit boards. The first product is the CPZ-4800x series of Single-Board Computers (SBCs). Based on the Z80A processor, these boards offer a Memory Management Unit (MMU), 4-channel DMA, Vectored Prioritized Interrupts (VPI), an SIO (or DART), a PIO, a 2793 FDC, 64K DRAM, and a built-in monitor in EPROM all in the same package. Low-level I/O (like RS-232 drivers and receivers, and floppy I/O configuration) is done via small "personality boards" that contain additional ICs and connectors. Using optional personality boards, the CPZ-4800x can support 5.25" or 8" drives, RS-232, SASI, Centronics, and many other peripheral devices. If you don't want to use them as masters in a TurboDos system, these boards also make dandy stand-alone CP/M systems.

After using two CPZ-48000 boards for the last four years, my only complaint is that a shorted regulator on an RS-232 personality module can cause SERIOUS damage to the main CPZ-48000 board, including destroyed traces and component failure (I've lost two boards this way). An added fuse has saved me from any additional failures. However, this problem exists in all S-100 boards that use personality modules (sometimes called "Paddle Boards"), and is not restricted to just ICM.

Slaves

ICM's 8-bit slave processors, the CPS-MX 64K and CPS-BMX 128K, are just as impressive as their SBCs. Running at 4 or 8MHz, the ICM slaves have most of the features of the SBCs, including on-board MMU and full DMA capability. Running as a memory-mapped slave under TurboDos, the CPS series slave processors are much faster than most of the I/O-mapped slave boards I've seen.

Like the SBCs, each CPS board has two serial ports, two parallel ports, and two CTCs. Most of the TurboDos gurus I've talked to have said that they find memory-mapped slaves faster than regular I/O-mapped slaves, but a great deal more difficult to implement. If you're running ICM's version or TurboDos, then this shouldn't be much of a problem, since they do it for you.

Hmmm... Out of space already. We'll have to continue this mini-review next time (starting with the ICM 16-bit stuff).

First Letter

I've received several interesting letters since last time. Much to the relief of my editors, I'm sure, I can't possibly answer all of them here. However, I do have room for a couple of them, so here goes:

Letter number one is from Matt Swarm of The S-100 Board Bank in

Olympia, WA. Matt is currently running a plain vanilla CP/M system, but is planning to upgrade to TurboDos as soon as he can get the hardware put together and debugged. Within his description of the hardware he is assembling, he mentions that he has picked up two Mitsubishi 8" half-height floppy drives and has heard that they're reliable, but is being driven crazy by the clatter they make each time the heads are loaded.

Matt also mentions that some of the S-100 cards he's using (particularly the single-board computers) are "real blast furnaces," and that he's thinking about bypassing the heat-generating regulator ICs on-board and supplying the boards directly with regulated power. He wants to know if anyone else has ever tried running S-100 cards with off-board power regulation.

I can offer some advice about the Mitsubishi floppies because I've been using them myself for the past couple of years on my RCPM system. I can vouch for their reliability, since two of them have been running non-stop without any failures or alignments since the spring of 1983.

As for the noise, there's a simple solution to that. The most annoying part is the loud snap made by the door locks every time the drive is accessed or the head is loaded. Because the door lock is a useless feature in most cases, you can simply defeat it by unplugging it or cutting the door lock relay wires.

If your equipment de-selects the drive automatically when it isn't being used (and thus turns off the DC spindle motor of the Mitsubishi), you can cut down the noise even more by defeating the head-load relay and leaving the heads loaded all the time. Because of the design of the drive, the heads are automatically separated when the disk door is open, even if the head-load relay is energized, so no damage can result from this.

I've modified all four of my Mitsubishi

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shi half-heights this way, and they're so quiet I can't even tell when they're being accessed. (These tricks can often be applied to other drives too, but you should be very careful about forcing a "head loaded" condition, particularly if the drive's spindle motor runs continuously, or if the heads must be unloaded prior to removing or inserting a diskette.)

About bypassing the on-board voltage regulators on S-100 cards to prevent excessive heat: Be Careful! If you do it right, you should have no problems, but you should beware of several things before you do it. One of the reasons for the on-board regulators in the first place is to prevent garbage signals from passing between boards via the power supply. Running two S-100 SBCs from the same power supply this way, for example, will probably not work. So be sure that the power lines going to the un-regulated board are adequately filtered (not just for "smooth" power, but also to trap out high frequency noise, switching transients, and the like).

Many of the single-board S-100 computers require extremely clean input power, and, after bypassing the regulators, will run reliably only with additional filter capacitors installed on the board itself. In addition, if forced-air cooling was required before the regulators were removed, it will probably still be required afterward.

Also, if you decide to remove the on-board regulators, be careful to do it in a way that prevents the board from being inadvertently connected to an unregulated S-100 supply, or else the board will change from a blast furnace to a pile of carbonized shredded wheat.

Second Letter

Letter number two is from Jeff J. Henkels (via GEMail). Jeff is designing a 68000-based CPU card to replace the Z80 card he's currently using in his S-100 system and would like additional information on how to control the interface between the 16-bit 68000 and the 8-bit memory, disc controller, and I/O cards.

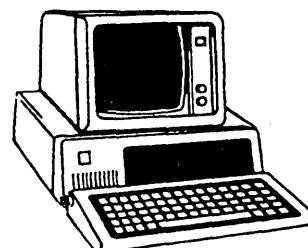
"To date," Jeff writes, "I have not seen this material covered in detail in any of the S-100/IEEE-696 literature. I am sure that there are many S-100

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hackers who would be very interested in seeing such an article."

Interestingly, I have a column (actually two) planned for just what you have mentioned — using 16-bit devices on the S-100 bus, with and without other 16-bit cards.

Although the IEEE-696 standard allows for 16-bit stuff on the S-100 bus without any "tricks" like multiplexing data/address lines, etc., there are several different schemes for "sneaking" 16-bit processors into an S-100 bus that has only 8-bit cards. Many manufacturers make 68K-based boards that use existing 8-bit cards, including Viasyn (a.k.a. Godbout; CompuPro) and Peak. Viasyn's scheme does some neat hardware tricks to allow the 68K's memory-mapped I/O to be translated to I/O mapping for S-100 peripherals, for example. And, of course, there are

a few timing tricks needed to shoe-horn the 68K into the S-100 bus, too. Peak's design lets the 68K reside in a system with another host processor that it uses for I/O, which makes installation painless.

Next Time

The next mini-review will cover the popular Earth Computers Z80 slave processor board. If you would like to see a mini-review of a certain S-100 product, please let me know, and I'll be happy to give it the once-over.

Of course, future columns will also include more letters from readers, S-100 tips, and hints. As always, I encourage reader feedback, and welcome questions, suggestions, comments, and ideas for future S-100 Bus columns.



LETTERS

(continued from page 4)

PC Hard Disk

My computer is an Epson QX-10 with a Titan PC-II board which makes it run almost like a PC. I'd love to add a hard disk to my system. I can buy one, but it costs \$1200 with the interface and control boards. I see hard disks advertised for the PC for under \$500 including the controller.

However, on my system (like the Kaypro) I still need an interface to the controller. I know it isn't worth your time to publish an article just for the Epson QX-10, but an article which would show how a Kaypro and any other system could use a PC hard disk might appeal to many of your readers.

John A. Clinkenbeard
5810 Woodbridge Lane
Midland MI 48640

Editor's note:

Excellent suggestion, John. However, check the PC-BIOS article in this issue. It would appear from that article that it would be much easier to do a SCSI interface, and add the winnie support to CP/M's BIOS (or as a driver in MS-DOS).

Anyone have any other suggestions?

Amiga Aficionado

I just read Issue 28 and feel I should speak out in defense of the Amiga. I bought mine in November (for some reason, we Canucks seem to have been blessed with availability well before our southern friends), and use it daily for writing letters, communicating with BBS'es, keeping track of marks, and programming in C.

There's no question that the graphics are mind-blowing (the Electronics Arts demo disk that comes with the machine is a good substitute for cheap drugs), but I like the AmigaDOS environment for business and programming applications as well. It's great to have a full-screen editor, text file sort utility, and file joiner all built into the DOS (not to mention the built-in RAMdisk!). It's also great to be downloading a file, printing a report, and editing a program — all at the same time.

Speaking of DOS, I haven't seen the rumored crashes, except when I run out of memory, and you sort of get a

feel for when that's going to happen. Anyway, all you need to do is re-boot (you don't need to reload Kickstart). The DOS that originally came with the machine (Version 1.0) had a few bugs (notably the serial drivers), but DOS 1.1 seems to have solved that.

My only complaints are:

1. No software. I have Delux Paint and Lattice C, but there's no business software out yet (Maximillian looked promising, but it wasn't compatible with DOS 1.1), and even the games are scarce so far. But with the open architecture and easy access to documentation, I think this will be short-term.

2. The software I do have (especially Lattice) seems to be of the opinion that, since there's lots of memory and disk space, there's no need for efficiency. For instance, the Lattice package takes up an entire 880K disk, with no room for the DOS functions. The familiar "Hello.C" program compiled to 15K. Where, oh where, are the days when you could fit your BASIC graphics program into 4K, with another 4K for the BASIC interpreter and operating system?

Lloyd Sumpster
#203 - 1740 Southmere Cres.
White Rock B.C. Canada V4A 6E4

Tips & Gotchas

In case you didn't know, the Ampro Little Board (and the Big Board, too, for all I know) can talk MIDI with a simple \$10 interface. It can run port B at 31.25Kbps; the rest is a 2mA current loop to RS-232 adaptor using a 6N138 opto (GI sells them for a lot less than HP).

If you're building a bare-board L-Band spooler, be advised that it will need a hardware patch if it's to use TI's TMS4164s. They're 8-bit-refresh 4 millisecond parts; the Z80 holds d7 low during RFSH* time, so half of each chip never gets a refresh. The board layout is quiet enough (free of electrical crosstalk) to use just about any Japanese 7-bit/2 millisecond RAMs that meet the access time, so why pay the extra? Good product, once I got that bug killed (I used TMS4164s). It's happily sitting in the rack box that holds the Ampro, two SA455s, and

two SA465s, and everybody runs on that switcher that BCD Electro has been selling for \$25. Excellent supply, by the way.

Watch out for solid-state Scientific HCMOS. I've had a couple of bus-killer failures with their 74HC245 (+5 shorted to a data bit). I'm keeping my eye on them. I got the parts from Jameco.

Carroll R. Bryan III WB1HKU/6
7311 Variel Ave #4
Canoga Park CA 91303

Reader Comments

As I filled out the Micro C renewal questionnaire, it was difficult to assign ratings to many of the things listed. Even though I gave (for instance) a zero to BBI, I still read most of the articles about the BBI because I often find something of interest in each article. I really read your publication from cover to cover. I'm mainly interested in my Z80 machine and now the 68000 machine. There is already much out there on Unix, so I don't think Micro C should get into that yet. Unix isn't so prevalent in the hobby, do-it-yourself world (yet). It's big and quite complex.

I'd like to see things on 68000 D-I-Y machines, especially S-100, because that's what I have. I would really like to see some articles on CDOS. I'm sure there are people out there with more knowledge than I have about how to get in and do the things that one can do with CP/M such as hard disks (without going to Cromemco).

Speaking of Cromemco, it really frosts me that they don't support CDOS and yet won't release the source code. They've forgotten those of us who bought their machines when they were working out of a garage in San Jose. We had confidence in them and helped make them a reasonably large company (our department at USC bought four machines), and now they turn their backs on us unless we fork over more big bucks. They completely ignore the hobbyists that they themselves were a part of. 'Nuf said.

Robert L. Amen
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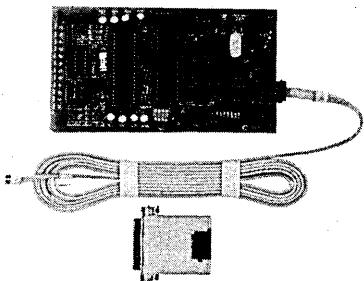
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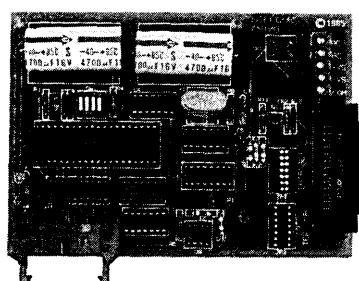


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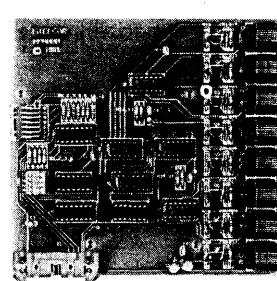


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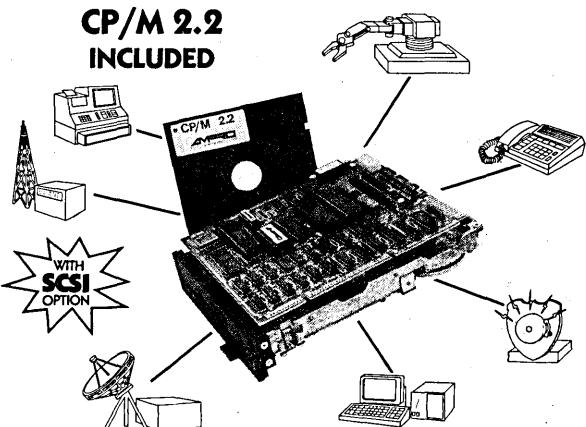
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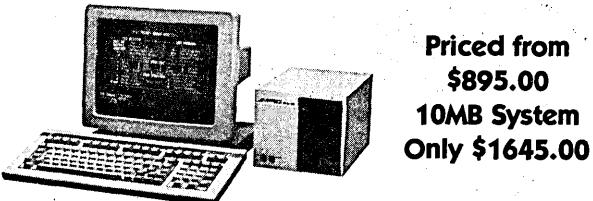
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EDITORIAL

(continued from page 2)

arena. (Our \$3,000+ Kaypro 286i isn't perceptibly faster and its AT style floppy/winnie controller has been a pain.)

The only thing I miss on the Holliston board (and on Gary's X-16 board) is the math co-processor. However, both Holliston and PC Tech are supposed to be finishing 8087 upgrades as I write this.

Holliston's will be an add-on board, PC Tech's 8087 will mount directly on their latest version of the processor board.

Floating Point Speed

It was The Culture Corner problem in Issue 29 that graphically pointed out the value of hardware floating point. (The problem was to find four numbers whose sum and product is 7.11.) I could have substituted integers for floats in this problem, but that kind of substitution wouldn't have worked in most other floating point situations.

I used a brute force method to search for the answer, which means that my program does lots of floating point operations.

Let's see, to test every possible number between 0 and 711 to see if its sum and product were equal it would take $711 \times 711 \times 711 \times 711$ passes. The program would do addition and multiplication of four floating point numbers in addition to numerous floating increments (much better than sinking increments) and floating comparisons.

I whittled the number of passes down significantly (to about $355 \times 355 \times 355$) which made the times at least workable.

Peter Casey (the C instructor who suggested the problem) tried running his brute force version on the college's PDP 11. After an overnight grind and no solution he gave up (they charge his account for each minute of CPU time).

I told him that I'd fire up a clone and see what I could come up with. Check out The Culture Corner for the solution and the next problem (chuckle, chuckle). And though my method was not elegant (I was not properly primed for this one), I did get the answer and a kind of perverse pleasure watching the systems struggle along. (All except the DS1 system.)

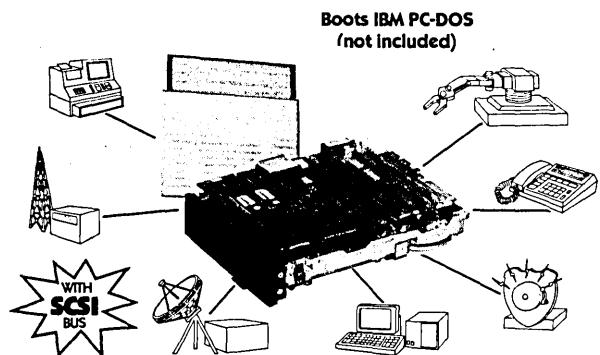
The C source was the same. The 8088 code was generated by Aztec C (I used the 8087 library to get the 8087 times). The DS1 version was compiled under Green Hills C. The times are shown in Figure 1.

The V20 system we used is a speeded-up Sky High clone in which we installed a V20 and switchable 22MHz and 14.31818MHz master crystals.

I know, I didn't tell you that you could use a 22MHz crystal. You can, if you're lucky. We haven't, however, gotten any clones to go 8MHz (24MHz crystal). At least not yet.

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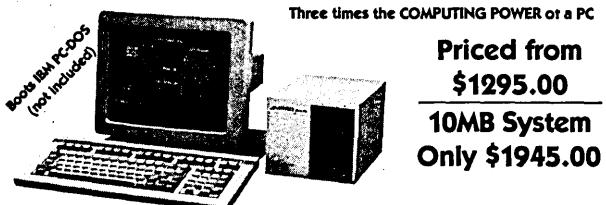
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MICRO CORNUCOPIA, #30, June-July 1986

Puzzles

Speaking of puzzles, we're getting a delightful number of really interesting responses to the puzzle in The Culture Corner in Issue 29. Again, see The Culture Corner for the solution to our insolvable product. One intrepid soul found the solution in under 27 min. 12 sec. using only paper and pencil. (Definitely not artificial intelligence.)

I'm looking for more such problems that we can solve. We received one for this issue, but we definitely want more, more, more. Look, in my spare time I'm either solving puzzles or making the editorial longer. It's your choice.

The Real Winner

Meanwhile, my brute force solution pointed out the value of a good floating point co-processor. National's floating point chip is obviously the fastest thing since the Turbo Porsche. (What, another Borland product?)

On the other hand, you can add a crystal, a V20, and an 8087 (get the 8MHz version) to a pokey little clone and do quite well. (Just be sure that the compiler you're using supports the 8087.) Also, take a look at Trevor's article in this issue for information on Motorola's new 68881 floating point co-processor.

Anyway, you can see why the DSI board has been so popular with the universities. Research data is usually of the floating point variety, and crunching floats is usually either slow (in software) or expensive.

In fact, one of the reasons IBM chose the 8086 series for the PC was the availability of the 8087. Though Motorola has had the 68000 out for a long time, it has had a devil of a time making the 68000's math chip go. (Math chips are about three times as complex as their CPU partners.)

Time

Speaking of system speed, I've recently discovered that time is only relative (my mother, who is about as relative as anyone I know, has no doubt mentioned this to me from time to time). It turns out that when you speed up

(continued next page)

Figure 1 - Puzzle Solution Times

System	time to solution:	FP proc.?
DSI-32	27 min 12 sec	yes
XT-186 8MHz 186	9 hrs 43 min	no
7.33 MHz V20	2 hrs 56 min	yes
7.33 MHz V20	15 hrs 49 min	no
4.77 MHz V20	4 hrs 31 min	yes
4.77 MHz V20	24 hrs 19 min	no
4.77 MHz 8088	41 hrs 18 min*	no

* The 8088's time was calculated from its performance relative to V20 in a similar (but much shorter) program. There's a limit to the amount of perverse pleasure I can stand.

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EDITORIAL

(continued from page 91)

an XT clone you also speed up its clock — that is, the hours, minutes, and seconds variety.

Some people have called and complained: "Hey, the time isn't right any more." (Only the system clock speeds up — a battery-backed real-time clock will be oblivious to the change.)

What they're really saying is that time is different, it's faster. Stop for a (6.67MHz) moment and consider the possibilities.

Let's say you have an 8-hour per day job compiling software. All you have to do is speed up your system and use it for both your compilations and to keep track of your time. You'll get the same amount of compilation done, but the day will go faster.

With your system running a mere 6.67MHz you could be out enjoying the outdoors in under six (4.77MHz) hours. With a 23MHz RISC processor, you might just have time for one pass and lunch (1 hr, 39 minutes) before streaking home.

Of course, you couldn't have your timer running at 23MHz all the time. After all, two-hour movies would last about four commercials and a station break (sometimes that happens already). Weekends would take about 10 hours flat. (I wonder what effect this would have on the space-time continuum.)

So you need two systems — a fast one for work, a really slow one at home, which probably explains why Apples have been so popular as home computers.

PROLOG

Borland has been developing PROLOG for the last 2 1/2 years, and it's been the best kept secret that I haven't been privy to. I pride myself with keeping my ear pretty close to the ground (so moles can whisper in it) and all I'd gotten on this one was a dirty ear canal.

Anyway, one week Philippe called AI "so much bunk and rubbish" and the next week he announced PROLOG. He figures he'll sell ten times as many copies of PROLOG as Pascal. That means about 5 million copies! At \$100 each!

AI

Much of the problem with AI is that people have expected too much. Even the name has something magically unreal about it. If it's going to be magic, let's make really good magic. Let's have AI understand the spoken word (even though humans can't do that after years of training).

With AI, computers should be able to solve problems (such as playing chess) more efficiently as they learn to deduce specific responses from general rules and create general rules from more specific experiences.

Of course, anyone who's seen 2001 knows exactly what AI will be able to do.

"Hello, David. How are you today?"

'I'm fine, Hal.'

"Does that mean that you had no parity errors this morning, Dave?"

'Not that I can recall, Hal.'

Our expectations for smart computers have come from the science fiction writers, and the writers have, so far, avoided the fetters of reality. When reality intrudes, AI has problems.

In real time, we're limited to poking around the edges. The computer needs senses and it needs a method for thinking.

For the senses, we are working on speech recognition, pattern recognition, odor detectors, ultrasonic positioning information, etc. For the thought, we are using languages like PROLOG to create giant condition tables.

If this is Wednesday,

and

I'm still with the tour group,
and

a car bomb hasn't blown up my hotel,

and

our plane wasn't hijacked,
then

this must be Dallas.

But thought? No. Computers aren't really thinking. At least not like people. And cognition isn't something that will be solved by more speed or more memory. It will be solved when cognition understands itself.

Where To For Micro C?

MS-DOS people complain that we're still just a CP/M magazine. CP/M people complain that we've become another PC rag. Well, we're a CP/M magazine becoming an 8086 magazine, a 68000 magazine, a hardware magazine, a software magazine, an AI magazine, a fun magazine, a serious magazine, and a CP/M magazine. And through it all we'll remain a build-it, prod-it, poke-around-in-it, SOGing, and puzzling kind of journal.

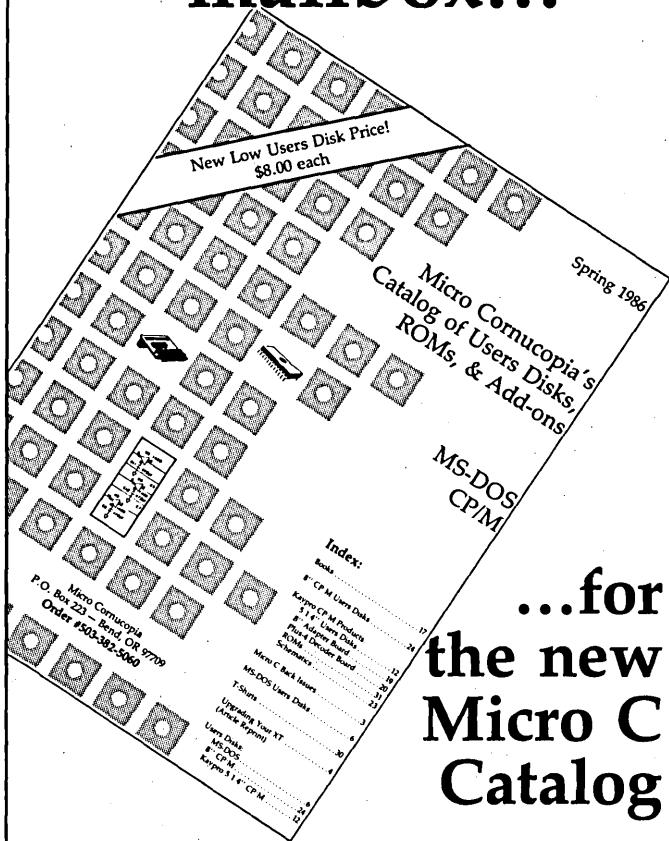
SOG

Meanwhile, if you're coming to SOG V, great. You'll be in super company. Calls and letters are pouring in from prospective attendees.

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Fast Step Rate For PC Disk Drives

By Larry Fogg

Micro C Staff

Anything worthwhile requires effort. In this case, however, Larry has found something very worthwhile that requires almost no effort at all. So, stepping right along...

In recent issues we've shown how to speed up the disk drive step rate for CP/M Kaypros. Now it's time for a Personal Clone version. But first, put down those soldering irons! This is a job for software.

Why Bother?

There are two benefits from changing the step rate. The obvious one is faster disk accesses. The CRC of a full disk went five percent faster when I cut the step rate from 8ms to 4ms.

But just as important is quieter drive operation. The neighborhood dogs used to surround my house and howl at the drives as they ground their way through long compilations. Now I can nap contentedly at the keyboard during even the wildest disk activity.

DPT Surgery

In order to change the step rate you'll need to perform a little surgery on the disk parameter table (DPT). This table contains a wealth of information on disk drive characteristics (see Table 1 for a complete description).

The first nibble (four bits) of the DPT determines the step rate. Hex values of C, D, E, and F give step rates of 8, 6, 4, and 2ms.

Presumably a value of G would yield a 0ms step rate and the fastest drives in town. 8ms is used by both the IBM BIOS and the Z-NIX BIOS which came with my clone. Teac 55BVs will run at 4ms while Mitsubishi 4851s are happy all the way down to 2ms. Experiment with your drives to find the best step rate.

The easiest way to change the con-

tents of the step rate nibble is to enter a little assembler routine with DEBUG. See Listing 1 for this procedure.

Note that the segment has been shown as ????, because DEBUG chooses a value for CS which will vary according to the configuration of your system. It's not really important what that value is. Also, don't add a trailing 'h' to any numbers. DEBUG assumes hex values and will be offended by your attempts to be explicit. Once the program has been saved it can be added to your AUTOEXEC.BAT file for execution on cold boot.

More Experiments

I've read that altering the head settling time can improve disk performance, but I saw no change at all using a range of values from 0 to 40.

Try experimenting with head settling and other parameters in the DPT as well. With a little creativity you can get yourself into all sorts of trouble. (What fun would it be otherwise.) So there you have it — quick, quiet drives without the need to molest your hardware.



Listing 1 - Assembler Routine

```
B>DEBUG
-A
????:0100 XOR AX,AX
????:0102 MOV DS,AX
????:0104 MOV BX,522
????:0107 MOV BYTE PTR [BX],EF
????:010A INT 20
????:010C
-NFASTSTEP.COM
-RCX
CX 0000
:C
:W
Writing 000C bytes
-Q
; invoke DEBUG's assembler
; set AX register to 0
; data segment starts at 0
; 522 is the offset of the DPT
; move new step rate (4 msec) into DPT
; return to DOS
; <cr> here exits assembler mode
; name file and set up FCB
; CX register must get file length
; current value in CX
; change to C (file is C bytes long)
; write the file to disk
; quit DEBUG
```

Table 1 - Disk Parameter Table

Byte	Action	IBM Value
1	high order=step rate	CF
2	high order=head unload time	02
3	delay for turning motor off	37
4	sector size in bytes (0=128 1=256 2=512 3=1024)	02
5	last sector number on a track	08
6	gap length between sectors	2A
7	data length	FF
8	gap length for use in format	50
9	fill byte (written to disk during format)	F6
10	delay for head settling (in milliseconds)	25
11	delay for motor start-up (in 1/8 seconds)	04

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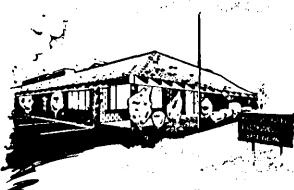
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TECHNICAL TIPS

Big Board II Tips

I've made a couple of changes to my BBII that other readers might find interesting.

The first problem I had was with the power-on reset. Half the time on power up (or if there was a glitch in the power line) the processor wouldn't reset properly. To make things worse, the reset button didn't work either due to the lack of an M1 cycle. So I decided to fix it once and for all.

The circuit diagram shown below was built in the bread board area of the BBII. The main feature is that the TI7705A senses the +5V line and doesn't start its delay until the +5V line is > 4.75V. Also, if it drops below 4.75V, the chip will start a reset cycle. Since I installed this circuit I have not had a single problem.

While I was at it, I also modified the clock circuit a bit. I changed U19 (a 74LS04) to a 74HC04. This cleaned up the drive waveform tremendously and decreased its rise time due to the larger dynamic range of the CMOS part.

Ken Carlson
1206 SE 140th Ave.
Vancouver WA 98684

25th Line Blues Fix

After installing the Pro-884 and the 8" drive adapter board in my Kaypro 4-84, and enabling the 25th line for time and date, I noticed that for approximately 15 minutes after turn on, the 25th line randomly filled with graphic characters. After 15 minutes everything worked okay (obviously heat related).

My solution? Using a heat gun and a can of quick freeze, I found that the octal latches U13 and U14 were the culprits. They are located on the main board near the rear left corner. They're both 74LS373s and cost about \$1 from JIM-PACK.

The small program shown below will clear and restore the 25th line at any time.

Edward J. Pierce
310 Hemingway Dr.
Bel Air MD 21014

Kaypro Cursor Location

We recently got a call from Richard Hudson wanting to know how to find the cursor value storage location on his Kaypro II and then alter the cursor.

Here's what we suggested: find the storage location for the cursor type using DDT; change the value with CONFIG 83; then go back and look at that location. If the value hasn't changed, you weren't at the right address. (This is obviously a hit and miss technique.) If the value has changed, a short BASIC program to poke the cursor value, or an assembler

program to load the value, will do the trick.

(For those of you with Pro 8s on your system, the cursor change is easy. Type Esc C followed by the character you want for the cursor.)

Richard wrote back to us a short time later to say that he'd found the storage location at FE91h (this is true only for a standard Kaypro II BIOS). Poking 1Fh restored the block. He also mentioned that much of the new public domain software seems to alter his cursor.

Micro C Staff

Figure 1 - New Big Board II Reset Circuit

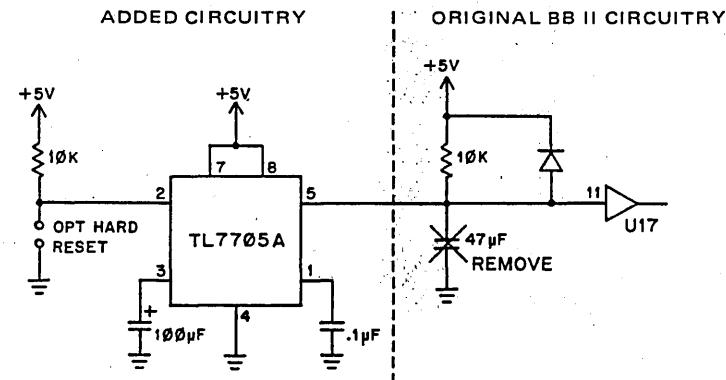


Figure 2 - Status Line Maintenance Program

```
; This program will clear the 25th (status) line on
; the Kaypro, and restore the date-time display.
; Call it on exit from various programs.
;
; Version 1.0          Written by
; 12 Sep 85           E.J. Pierce
;
ESC    EQU    1BH
BDOS   EQU    5
;
START  ORG    100H
       MVI    C,9           ; save cursor position 1st
       LXI    D,SAVEC
       CALL   BDOS
       MVI    C,9           ; console out
       LXI    D,CMSG
       CALL   BDOS
       MVI    C,9           ; do it!
       LXI    D,RESTC
       CALL   BDOS
       JMP    O              ; return
;
CMSG   DB     ESC,'C7',ESC,'B7',ESC,'B8','$'
SAVEC  DB     ESC,'B6','$'
RESTC  DB     ESC,'C6','$'
;
; so be it.
```

CP/M Turbo Pascal V3.00A Patch

Tired of saying YES (or NO) to Turbo's "Include error messages (Y/N)?" If you are, then use this patch to have Turbo always (or never) load the TURBO.MSG file. Use DDT to load a copy of your compiler (TURBO.COM) into memory. Then simply change the three bytes at locations 222Ch-222Eh. To have Turbo always load the error messages, change as follows:

222C CD -> AF

222D 21 -> 3D

222E 2D -> 00

To have Turbo never load the error messages, change as follows:

222C CD -> AF

222D 21 -> 00

222E 2D -> 00

Then exit DDT and do a "save 121 <filename.com>". After you verify that the change works and the compiler is intact, rename the file "TURBO.COM" for your working disk.

D.K. Smith

1747 Attridge Rd.

Churchville NY 14428

Fixing 1 Meg RAMdisk

The new BI/820-1M one megabyte board for the Big Board recently advertised by Jim Ferguson in Micro C doesn't work as shipped. If you write a byte at 4000H, for example, it will read back at 8000H, and so on for other banks. There is a pin inversion on the schematics and on the printed circuit board at (U43-4, U43-5), (U46-4, U46-5).

For U43 and U46: RA is pin 5, RB is pin 4. To correct the problem, do the following:

1. Cut the trace on top of the board, from U44-9 to the hole.
2. Cut the trace under the board, from U44-11 to the hole.
3. Jumper (under the board) U44-11 to the hole that was going to U44-9.
4. Jumper (under the board) U44-9 to the hole that was going to U44-11.

Note that this new board, as well as the old 256K board, works perfectly at 6MHz with 150ns DRAMs.

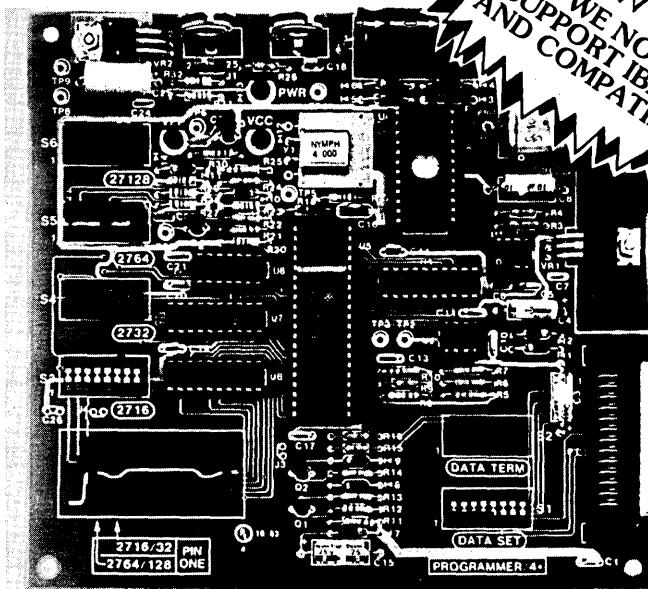
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By Gary Entsminger

But It's On That Disk, I Know It!

File Recovery In MS-DOS

Every now and then, no matter how conscientious I think I've been, I forget to back up a working disk. Most recently, my forgetfulness began to haunt me just after I'd accumulated a dozen articles for this issue of Micro C.

Naturally, I didn't know I'd been forgetful (negligent is too strong a word!) until my disk failed to respond to a prompt. "Disk error reading drive B:", DOS reported. "Abort, Retry, Ignore?". I tried all three with equal success.

Then I tried several utilities (DEBUG, EASY-ZAP, CHKDSK) and equalled my previous success, concluding that I had a problem.

Track 0, Side 1, Sector 6, the first sector of the directory, was shot, caput, incapacitated, out-to-lunch. It was no laughing matter.

The problem is that most programs capable of reading disk sectors succeed only when they can access directory or file allocation data, and that was precisely what I didn't have.

I needed a program which bypassed the directory and file allocation table and checked each sector directly. Fortunately, I found just the program (if I'd had to write a program to rescue my text, Issue #30 would have undoubtedly followed #31).

SSAR (for Special-Search-And-Recovery) came to my rescue. It's one of the Norton Utilities, and although

limited (it only recovers text), it solved my problem.

When it finds text, SSAR transfers it to a special file on a disk in drive b. The transferred data is marked with sector and end-of-file boundaries, making it easier to reconstruct files.

So I put it to work, and 25 minutes later (yes, it does take time to recover from forgetfulness) I had a text file 227K long ready for editing.

Relieved? You bet I was.

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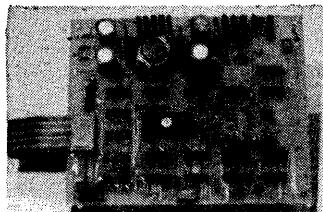
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Metamagical Themes

If you haven't read a Douglas Hofstadter book or article, you're missing out.

His Pulitzer Prize winning "Godel, Escher, Bach" turned heads back in '79, with a blend of philosophy, wit, and humor encompassing a range of subjects from the structure of DNA, self-reproductive art, incompleteness theorems, the Turing machine, and artificial intelligence to fugues, counterpoint, and poetry (including limericks).

His most recent book, "Metamagical Themes," is equally intriguing, despite an almost presumptuous subtitle, "Questing for the Essence of Mind and Pattern."

Three chapters in particular should appeal to the would-be (or already groomed) computer guru — LISP: Atoms and Lists, LISP: Lists and Recursion, and LISP: Recursion and Generality.

Together they compose a tidy and stimulating introduction to LISP, A.I. (from a programmer's perspective), and recursion. Here's a bit of his wit in an explanation and solution of the Towers of Brahma (or Hanoi) puzzle.

"In the great Temple of Brahma in Benares, on a brass plate beneath the dome that marks the Center of the World, there are 64 disks of pure gold which the priests carry one at a time between three diamond needles according to Brahma's immutable law: No disk may be placed on a smaller disk. In the Beginning of the World, all 64 disks formed the Tower of Brahma on one needle. Now, however, the process of transfer of the tower from one needle to the other is in midcourse. When the last disk is finally in place, once again forming the Tower of Brahma but on a different needle, then will come the End of the World, and all will turn to dust.

"Earlier I pointed out that recursion is evident enough: to transfer 64 disks from one needle to another (using a third), it suffices to know how to transfer 63 disks from one needle to another (using a third).

"Now someone might complain that I left out all the hard parts: magically assuming an ability to move 63 disks! So it might seem, but there's nothing magical about it. After all, to move 63, you merely need to know how to move 62. And to move 62, you merely need to know how to move 61. On it goes down the line, until

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you bottom out at the embryonic case... Now, I'll have to admit that you have to keep track of where you are in the process, and that may be a bit tedious — but that's merely bookkeeping. In principle, you could actually carry out the process — if you were bent on seeing the world end!"

It's 800-plus pages of structure and strangeness from Basic Books. \$24.95 in H/C.

Pascal Runoff Take 3

Of course you're not going to believe it, but we omitted another Pascal Runoff entrant.

Frank Jones was indeed a bona fide participant, and his program, NFILELST, was considered and judged along with the 126 other entries.

It's just that, well, we have serious trouble keeping up with slips of paper (especially ones with names on them) around here. (Obviously, no one submitted a Pascal Runoff Contestant Name Preservation and Organization Program.)

Sorry, Frank.

The Visible Computer: 8088

This is it — the best 8088 assembly language tutorial we've encountered (almost too good to be true).

"The Visible Computer: 8088" is a program and a book. The program

(TVC, a sophisticated debugger) simulates the PC's processor, taking you inside the 8088 as it executes programs. An attractive display of a half dozen windows allows you to monitor CPU registers, memory, flag status, and instruction execution simultaneously.

A variable step rate function lets you determine the rate of execution (so you don't have to miss an iota of micro code). And a command line allows you to interrupt and direct simulation with a keystroke.

The book is an excellent 350-page introductory (assumes nothing) text written with wit and style (it even makes segment addressing sound easy).

And once you've gotten the hang of assembler, you can use TVC to debug sophisticated programs (most of the commands and capabilities are compatible with DEBUG).

In short, "The Visible Computer: 8088" is a winner; we highly recommend it.

For more info contact —
Software Masters Costs \$79.95
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And that, friends, is all the Tidbits fit to bite into this issue.

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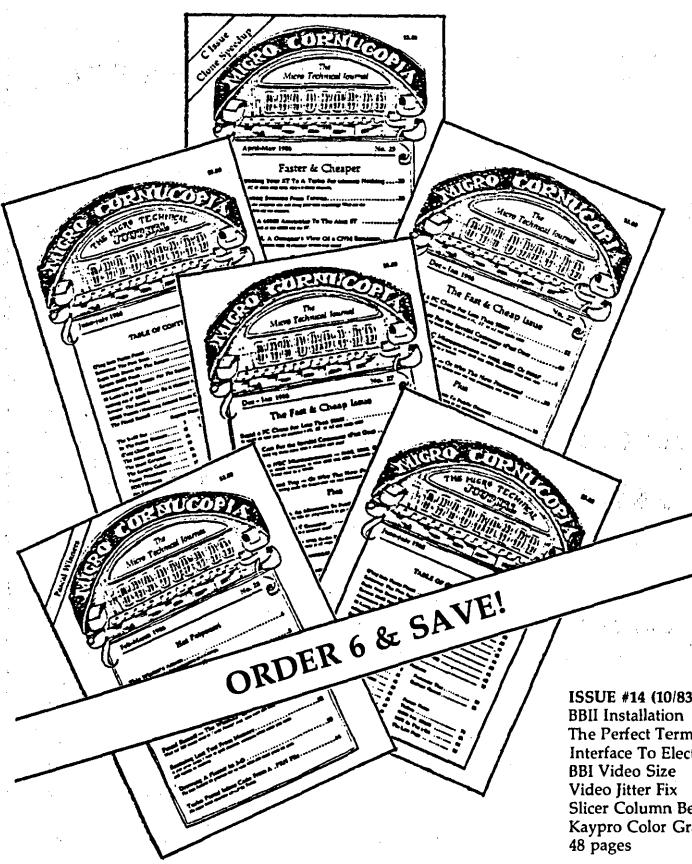
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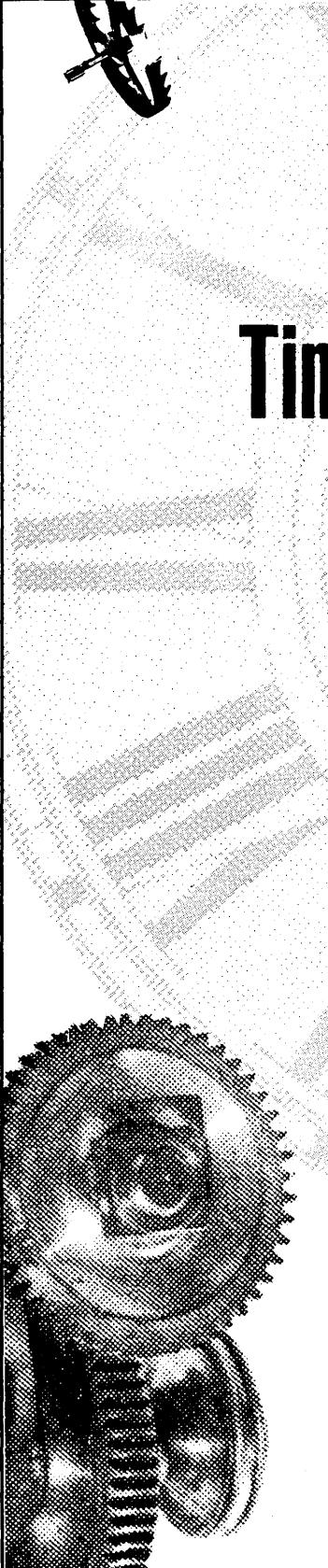
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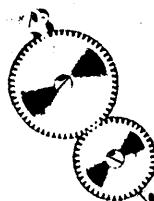
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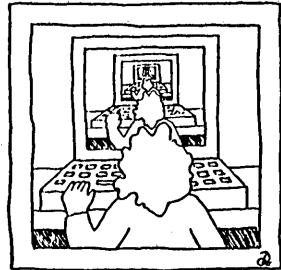
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THE LAST PAGE

(((((Recursion))))))

By Gary Entsminger



Recursion In Turbo Pascal And PROLOG

When a function (or procedure) invokes itself we call the process recursion. A simple, and fundamental, application is a function for calculating the factorial of a number.

A factorial is the product of a number times itself minus 1, times itself minus 1, times itself minus 1, etc., down to 1. For example, $6!(\text{factorial})$ is

—
6 * 5 * 4 * 3 * 2 * 1

or 720. (It adds up quickly.)

If we look closer, we see that $6!$ is also equal to $6 * 5!$. And $5!$ is equal $5 * 4!$, etc. Or —

$N! = N * (N-1)!$

In other words, to solve $N!$, we call the factorial function substituting " $N-1$ " for " N " until we reach the limiting condition, $N-1 = 1$.

In Pascal

Let's look at the recursive function in Turbo.

```
Function Factorial(N:integer):integer;
Begin
  If N > 1 then
    Factorial := N * Factorial(N-1)
  else Factorial := 1
End;
```

System Perspective

From the computer's perspective, when a procedure (or function) calls another procedure, its formal parameters and local variables are pushed onto the stack, along with the return address of the calling procedure. (The system needs to know where to return control after it's finished handling the procedure.) Then control is passed to the called procedure.

When the procedure has finished executing, it retrieves the return address from the stack and then pops the variables and formal parameters.

Control is then returned to the calling procedure.

If a procedure calls itself (recursion), the same pushing and popping occurs. Each time the procedure calls itself, it pushes another set of variables and parameters onto the stack. Eventually, if the procedure calls itself too many times, the stack overflows (fills to the point that it starts writing over other data) and crashes the system.

It's always possible, in principle, to find a non-recursive solution, and although the non-recursive solution may be slightly more efficient (sometimes), it can obscure the algorithm. For example, we could use iteration to solve a factorial —

```
Begin
  p:= 1;
  While n > 1 Do
    p:= n * p;
    n:= n - 1
End;
```

The obscurity becomes more obvious in complex problems, such as the 8 Queens solution, the Quicksort (invented by C.A.R. Hoare), and in programs to generate permutations (see "Programming In Modula-2" by Niklaus Wirth). (Obvious obscurity, an oxymoron perhaps?)

In PROLOG

A logic programming language, PROLOG (for PROGramming in LOGic) relies (you might say, thrives) on recursion, since it lacks primitive functions for iteration. Let's examine the factorial function in the two principle PROLOG syntaxes — micro-PROLOG and Edinburgh.

First in micro-PROLOG —

```
1 factorial 1
x factorial y if
  1 LESS x &
  SUM(x1 1 x) &
  x1 factorial y1 &
  TIMES(x y1 y)
```

We define a fact (the factorial of 1 is 1) and a rule (x factorial y if...) for finding factorials greater than 1.

If you're unfamiliar with PROLOG, try reading the function this way —

Given x , to find y such that x factorial y , if $x=1$, $y=1$ (1 factorial 1) or if $x > 1$ (1 LESS x), subtract 1 from x to get $x1$ ($\text{SUM}(x1 1 x)$), and find $y1$ such that $x1$ factorial $y1$, and multiply x by $y1$ to get y .

Or in other words, call the factorial function recursively until $x = 1$.

In the Edinburgh syntax —

```
factorial(1,1).
factorial(X,Y) :- 
  X > 1,
  Z is X - 1,
  factorial(Z,A),
  Y is A * X.
```

gives the same result.

More Recursion

Although recursion has been around as an idea for centuries (an obsolete definition in the O.E.D. defines it as "a backward movement"), the increasing popularity of PROLOG (and descriptive programming in general) will no doubt lead to more and more discussions about it (which will no doubt lead to more and more discussions about it).

Recursion is a powerful technique for describing structures and programs succinctly, now affordable on micro-computers thanks to the larger memories currently available on PCs.

For more information about recursion and PROLOG in general, see "Programming in PROLOG" by Clocksin and Mellish and "micro-PROLOG: Programming in Logic" by Clark and McCabe.



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