

TEXAS INSTRUMENTS

TI Forum

by Ron Albright
& Jonathan Zittrain

One of the cruelist realities of using an "orphaned" machine is the steady decline of commercial software support. Because of the economic realities of software development for a shrinking market, commercial software progressively slows. As the ability of consumers to rely on third-party support dwindles, the residents of the orphanage, then, have a couple of choices: they can sell out and buy a fully supported machine, or they can take up the challenge and start writing their own software. In the TI community, that latter option has become much more viable of late with the availability of a powerful new language for our machine. Namely, "c99" from Clint Pulley (Fairware; send two disks, return mailer and a suggested contribution of \$20 to Clint Pulley, 38 Townsend Avenue, Burlington, Ontario, Canada L7T 1Y6).

A variant of "small c" developed by Ron Cain in the early 1980s, "c99" is the first compiled language for the TI. What does that mean? By writing programs using c99 syntax and running the source through the c99 compiler, the output code is assembly source code. The resultant code can then be assembled using the Editor/Assembler package from TI into runnable object code which is many fold faster at run-time and more efficient than BASIC or other non-compiled languages. Further, C syntax is relatively easy to learn as a second language and, at least for me, was quite similar to programming concepts I had previously developed in Basic and Extended Basic. I could never learn assembly programming and Forth was difficult to grasp with its stack and RPN. I have found C syntax a relatively easy transition "step-up" for me as a programmer. With the release of version 2.0 of the c99 compiler by Pulley and the additional libraries from others that allow for speech, sound, and floating point, c99 has achieved an increasingly popular spot for programming on the TI. An added benefit of learning c99 is that it is a subset of full C. Code you write in c99 syntax can easily be ported

to other machines. Since C is available for virtually every machine on the market today (the op system for the Amiga was written in C), learning c99 now will stand you in good stead in the future should you ever decide to change machines. You will have learned a language that you can use long into the future of your computing needs.

What do you get? The c99 system disk contains several files. There is an adequate manual provided by the author that covers the basics of how to run the compiler, the limitations of c99 (useful as you start to type in programs from books about full C) and several example programs with source code to examine. The manual will not teach you the C programming language. You will need to buy a book for that (I recommend "C Primer Plus" by Waite, et al; Sams Publishing Co., 1984; \$21.95). Let's look briefly at the mechanics of how the system works.

I will make a few assumptions to start. First, I will assume you have a single-drive system with only single-sided capability. Second, I will assume that you have a basic understanding of the Editor/Assembler package, i.e. you know how to use the Editor, and run programs out of either option 3 or option 5. I will, further, assume, that you have assembled at least one source code file with E/A. If these assumptions are incorrect, let me know and we'll touch on the Editor/Assembler more next time. Let's get started.

Take a clean disk and copy the following c99 files onto it:

CSUP D/F 80	12 Sectors
PRINTF D/F 80	14 Sectors
UTIL1 PROGRAM	33 Sectors
UTIL2 PROGRAM	33 Sectors
UTIL3 PROGRAM	29 Sectors

Next, from the Editor/Assembler disk, copy these files to the same disk:

ASSM1 PROGRAM	33 Sectors
ASSM2 PROGRAM	20 Sectors
EDIT1 PROGRAM	25 Sectors

If my addition is correct, that gives us 199 sectors on our work disk. Now we are ready to proceed. Keep our work disk in the drive and insert the Editor/Assembler cartridge. From the menu, load the Editor and go into the Edit mode.

Type in this program.

```
" c99 The smallest c99 program "
main 0 /* a moment */
{
/* we aren't going to do anything! */
}
```

Congratulations! You have just entered your first, valid c99 program. Let's look at it. The first line is nothing more than a "REM" statement. Instead of REM, c99 recognizes anything enclosed within "/* */" as a comment and ignores it when compiling. You can put anything between these comment delimiters, and it will survive compiling without error. Use them frequently as you program. As we mentioned, c99 programs are difficult to read at best and REM statements are useful to remind yourself, as well as other reading the program, what you had in mind. As shown on the next program line, they can also be used on the same line as compilable code, so comment each step of your code for clarity. A routine called "main" is required somewhere in each

and every c99 program. Typically, it is the first block of code, sets things up, and calls the other then a series of "GOSUB"s (really, a series of "CALL SUB routines). Each function call doing its task and returning control back to the main, or controlling program. The good c99 program will break large programs into smaller ones and write a function for each. If a function can stand alone (has nothing in it unique to a single program) the programmer eventually develops a "toolbox" of useful small routines (functions) that can be combined in different ways to solve problems. That is just one of the beauties of c99.

So, let's compile this program. After typing it in, hit FCTN 9 twice, get the EDITOR menu and elect to save it to disk. Your main work disk should have plenty of room, so no disk swapping is required. After saving to disk 1, hit FCTN 9 again, and get the main E/A menu. Choose Option 5 to "RUN PROGRAM FILE". The three compiler

files, which I have renamed UTIL1, UTIL2, UTIL3, run out of option 5, not option 3 (which runs D/F80 files). When you are prompted for "Program Name:", since you have changed the name of your compiler files to UTIL1-3, you only have to hit enter. The default name for E/A 5 is UTIL1 and those files will then be loaded automatically (now you see why I renamed them). You will then be prompted by the c99 compiler (prompts will vary depending on which version of c99 you use) for a input file name. Type "DSK1.filename" (filename being generic for whatever you called the file you typed in and saved to disk). You will then be prompted for an output file name. Call it "filename/C", just to remind yourself that it is a compiled file. Then, hit enter and you are off and running. The compiler will flash each function name on the screen as it is compiled to show you where you are in the program. You

continued on page 74

A Layman's Guide to Understanding Artificial Intelligence (AI) Part III

by Dick Evans

Computers have been a part of education for some 25 years now. Intelligent computers are relatively new. The size and cost of AI computers has kept them out of the mainstream. With the advances we have seen in technology over the past few years, the power of yesteryear's very large mainframe is now available in a file cabinet sized super mini. Even the current micros are becoming quite powerful.

Intelligent computer-assisted instruction (ICAI) is just another of the evolutionary steps being taken. When the computer first came to education, it was a research tool. It soon became the teacher's assistant. Now, it can replace an instructor. Algorithmic computer based instructional material was only as good as the program. It amounted to little more than an electronic page turner for a programmed text.

The heuristic reasoning ability of the AI based com-

puter assistant provides greater flexibility. The increases in speed and capacity allow the system to hold more information. All of this is at little discernable reduction in presentation speed, which now include the addition of colors, higher resolution, sound and animation. One of the tools that is available now is a program development package that allows the non-computer expert to produce a very sophisticated instructional program.

At your fingertips, the best instructor in any subject you care to study. Think of the advances you can make. Think beyond that, to the advances that the expert can make now that some of the instructional burden has been lifted. We have returned to knowledge engineers and domain experts. We are looking at the ability of two people to expand their potential.

Like the expert system's three parts, knowledge base, inference engine and user in-

terface, the ICAI system has three parts. The problem-solving expertise is this system's inference engine. The knowledge base consists of two parts, the student model and the tutoring module. The user interface is still the user interface. Through interaction, the ICAI system can determine the student's level of understanding or misunderstanding. It then starts its teaching from that point.

This same technique is being applied to the development of software. Some of the reasons for this are the need for more and better programs in less time and the limitations of the human programmers. Using AI techniques, the programmer is provided with the tools to work better. AI software development tools provide expert assistance in the design and organization of software. Code generation programs actually produce high level language source code in

continued on page 184

Dallas 1986 Achieving Your Potential TI-MIX International Computer Symposium

by Dick Evans

This show was not for the user. TI's VARs were well catered to and the end users were ignored almost totally; the exceptions will be covered a little later on. All of the exhibitors and the majority of the session speakers addressed the needs of the VAR. You may conclude that this is a continuation of the trend indicated by the advertising TI has done to recruit VARs.

The announcement of the new 32-bit 1,500 machine was very well done, no surprise, just a very well done formal show. One of the points stressed was its IBM compatibility. One of the points not mentioned is the steady withdrawal of TI from all products not IBM compatible. This coincides with TI's withdrawal from end user support.

These impressions were reinforced by the following observations:

- There were no new products, soft or hard, introduced for the TIPC.
- MS-DOS, ver. 2.13 has been termed a "mature" product for which no enhancement are planned.
- TI announced that it will no longer re-package Microsoft products. It will assume the role of reseller and the product

will ship in the Microsoft package.

• Many user questions were answered with the question "Have you talked to your VAR about this?"

It was also interesting to note that there were no Pro-Lites being used, displayed or mentioned at any time during the entire show. When asked specifically about providing IBM compatibility for the TIPC, TI said that it has not found a suitable means for doing this. They also said that they had no plans to continue looking. If such a product is to be marketed, it must come from a third party developer.

The TI Professional Computer

By now you may have guessed that the TIPC is an "undeclared orphan." You have guessed correctly! Perhaps its passing will be quieter than the bombshell that burst when the 99/4A was orphaned. Both the TI Pro and the Portable Pro have joined the ranks of the unsupported. There will be the usual inventory of repair parts available for the usual period of time. There may be a few new software releases from the larger developers in the near future; however there are no long term plans, known to me, for hardware or software support of the TIPC/TIPPC by its parent or

any of the large developers. The Pro is "dead." But — long live the Pro! The previously mentioned absence of the Pro-Lite should be an adequate comment on its future too.

Is There Any End User Support?

Has overall supervisory responsibility for the organization and must balance its efforts between the end users of TIPC's and Business Systems while still addressing the needs of systems managers. Mr. Robert Teague is the Chairman.

The End Users' Council

An arm of the Board of Directors dedicated to the support of end users, especially the TIPC. This group is currently at work producing an "End Users' Manual" for the TIPC which should be distributed in the near future. They are also working on plans to expand their user support through an interface with the TI Information Network and a local BBS dedicated to the TIPC. Mr. Quentin Dolecek is the Chairman.

The Board Of Governors

This is a new group, yet to be formed, made up of the Chairpersons of the local RIXs. They will also be an arm of the Board of Directors and serve as a liaison between the General Board and the user. One side effect of this reorganization will be to effectively move the RIX from a semi-independent operating unit to a chapter of the TI-MIX organization. This should provide closer cooperation, better communications and improved support for the RIX and its user members. It has no Chairperson at this time.

Directions Magazine:

This is the monthly magazine of TI-MIX and its hardcopy means of communications. Financially supported by its advertisers and editorially staffed by a few very dedicated individuals, it does an always improving and impressive job of informing its readership. Guided by the policies of the Board of Directors, Miss Lark Doley, Publisher and Mrs. Rosemary Colgrove, Editor, mail about 20,000 copies each month.

The contents are supplied by a small, but growing, group of "volunteers" who receive only the satisfaction of knowing that they are helping the users as compensation. With the orphaning of the TIPC and the introduction of the Business System 1500, you can expect to see an increase in the articles and helps for both systems.

TI Professional Computing Magazine

Under the editorship of Mr. Harold Sims, this publication provided a wealth of information and support for the TIPC users. Harold is no longer with PCI, owner of the magazine, so we will have to wait and see who the new editor is and what is provided.

The TI Information Network

One of the SIGs on the DELPHI information distribution system, it is dedicated to supporting all TI computer products from the 99/4A through the Business Minis. Expanded end user support is now being provided in the form of Teledata, Inc.'s presence as a vendor and resource for the 99ers. TELEDATA will be assisting RANDYH. An electronic RIX,

known as RIX on-line, is being formed to provide the more isolated TIPC and Business System users with a mutual support group as well as a way to become a participating unit in the TI-MIX organization.

Through its interface with both Tymnet and Uninet, DELPHI and the TIIN can be accessed from over 500 U.S. cities locally and over 65 foreign countries. This provides users and groups with almost worldwide telecommunications capability.

During the Dallas Symposium, TI-MIX/Directions, *TI Professional Computing Magazine* and TIs Artificial Intelligence (AI) Group expressed interest in participation. ELLISCO, the TIIN Manager, will keep you informed, online, of the latest developments

TIPC Network

This is an independent organization recommended by the End User Council Chairman as a source of hardware components for your TIPC. They are very small and sometimes appear to be unresponsive. Hopefully, maturity will solve this current situation. I have also been told that they will soon be offering software for TIPC's.

Computer Shopper

Not TI specific but very TI supportive, Mr. Stan Veit, Editor, is providing me with the opportunity to reach users and groups with another information and assistance resource. As an owner/user of a TIPC, I am biased toward my machine. I am also practical enough to know that you are

continued on page 181

New Programs! For The TI-99/4A

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For more information contact: Quality 99 SoftwareWARE, 1884 Columbia Rd. #1021, Washington DC 20009, (202) 667-3574.

Mention that you read about it in *Computer Shopper*. •

TI Forum continued from page 73

should see only "main" if you are compiling the first program, and "main", then "doit" if you are compiling the second routine. If an error is encountered, you will be told. But we'll assume you typed these short routines in without error for now. It shouldn't take long and you are told to press enter to continue after the compiler is finished.

Now what? If you catalog your disk now, you should see the initial source code file you typed in and saved, and now a second file called "filename/C". Both should be D/V80. You have one more

step to do before you can run the program. What the compiler produced was assembly language source code. Like all source code, it has to be assembled. Get to the main E/A menu and choose Option 2, Assemble. When asked to "Load Assembler?", hit "Y", and since we put the E/A assembler files on disk 1 (ASSM1 and ASSM2) they should load right in without swapping disks. You are then prompted for the "Source File Name". Type in "DSK1.filename/C" (NOT the program you typed in and saved, but the compiler's output filename). For an "Output File Name", I use "DSK1.filename/O" to let me know this is object code.

Then hit enter for each of the next two assembler prompts ("List File Name" and "Options"). The assembler should start right up and finish with the assembly process. Now, catalog your disk again. You should see a third file added now — "filename/O". This time, it is not D/V80, but D/F80. Assembly language OBJECT code. You have produced an assembly language program. How do you run this "do nothing" program you have written? Go back to the main E/A menu again. Choose Option 3 from the menu. When asked for "File Name", type in "DSK1.filename/O"

continued on page 181

Achieving Your Potential
continued from page 74

not looking for "hype" from TI. Providing you with objective information and practical assistance will benefit all of us. Also, the *Computer Shopper* is independent of all of the other groups and organizations listed above. This means we have an unbiased forum to discuss the good and bad points about everything TI. I also feel that Stan is mature enough to accept constructive criticism of his publication, if it is appropriate. I must also do the same. Your comments and support are welcome.

Some years ago TI orphaned the home computer (99/4A) and it is alive and well today. It started out with less support in place than is currently available for the newly orphaned Professional (TIPC). While the future is not all bright and positive, I do not see the TIPC disappearing anytime in the near future.

There are third party software and hardware developers hard at work on TIPC products. Most of the big developers will withdraw, unless they perceive a viable market. This should leave more than adequate room for smaller developers to fill the gap with TIPC specific products. It might also provide some dedicated individual or group with a new enterprise — porting other developers latest products to the TIPC.

My current assessment of the situation is that while it may be an orphan, the TIPC is not only alive and well today, it will remain that way for years to come. The Pro is dead, long live the Pro!

Zuckerboard

continued from page 180

board with 256K of memory and want to upgrade it to 512K it is a simple matter of adding eight 256K chips and moving the one jumper to the 640K position. It should be obvious that you need to remove the board to carry out this procedure and then re-install it when you are through. Repeat the original installation procedure to install the board again.

I am using the board without any problems. I am impressed with its performance and its price. I would like to see them add the 232 port to the board since the Tandy 1000 is limited to three slots and you run out of room in a hurry. For the price you can't go wrong with the Zuckerboard!

Zuckerboard
Tandy 1000
Advanced Transducer Devices, Inc.
1287 Lawrence Station Road
Sunnyvale, CA 94089

TI Forum
continued from page 74

Then hit enter. You get the same prompt again ("File Name:"). This time, type "DK1.CSUP". This "c99 Support" file MUST be loaded after you load ANY c99 program. Hit enter. When you get the prompt for the third filename, just hit enter this time. When asked for the "Program Name", type in "START". All c99 programs run with the program name start. Your do nothing, super-duper assembly language program should now "run". You then immediately get the "hit enter to continue" message and you have finished.

Well, how does it feel to have generated an assembly language program just like the "big boys"? For now, I just wanted to go through the mechanics of running the c99 system. If there is interest, we will make this an ongoing tutorial in c99. Write us at *Computer Shopper*. For those that write we will answer back and include a free handy-dandy programmer's reference sheet (developed by the Puget Sound 99'ers) that will help you with programming in c99 or BASIC. Just ask for it and it's yours. We may even throw in a few other c99 goodies if you ask for them. But you have to write and ask. We also plan

a programming contest in the near future.

Expanding Your TI-99/4A

You have paid \$75 for your TI-99/4A console and hooked it up to your TV set. Now, some money has been set aside for expanding the computer, and you are all ready to begin. Where do you start?

The first thing to keep in mind is that additional components for your computer will in most cases exceed the original price of the computer. That is certainly ironic, but if you can think of it as being lucky enough to get the console at the price you did — and not at finding the components to

be overpriced, you are in good shape. The TI-99/4A, even in today's world of the Atari ST, Commodore Amiga, et al., can still hold its own.

What exactly would you like your computer to do? Many people who purchase computers have no specific reason in mind, hoping that the computer may "help out in-business" or "teach the kids." Contrary to the television commercials, few computers can merely be plugged in, flipped on, and then start vacuuming the living room or getting the kids into Harvard. But a bit of time, money, and effort can go

continued on page 182



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C.O.D.

TI Forum
continued from page 181
a long way towards meeting realistic goals.

The TI BASIC programming language included with the console is not extremely flexible, and relatively few programs are available for use with console BASIC. Extended BASIC, a plug-in cartridge originally from TI itself, is BASIC and then some. Speed is increased, and quite a few extra commands and abilities have been added. Whether you are interested in BASIC programming or would like to

take a small step in expanding your console, Extended BASIC can help. The price for a TI or third party Extended BASIC module should be under \$50.

The next leap in expanding the TI-99/4A can be for file and program storage. With a \$10 cable, a cassette recorder can be attached to store various programs and files, but cassettes are slow, unreliable, and inefficient. Cassette storage is sufficient for the very beginning, but the next alternative, disk drives, are much better. Disk drives use diskettes (also called "disks"; I do not know

why there seems to be male and female varieties) like cassette recorders uses cassettes. With a disk drive, programs and files can be loaded and saved in seconds, and in any order. Programs and files can be given names on a disk, so "OLD DSKI.MYPROGRAM" would load the program called MYPROGRAM, picking it out from among the other programs available on the disk. Like a record player, a disk drive can move in jumps from program to program, unconcerned with beginnings or endings. Hence a disk uses

RELATIVE filing, while a cassette can only be SEQUENTIAL — strung out from one end to the other, and listened to in only one order.

To connect a disk drive to a 99/4A, a "controller" is also needed. The controller can be a separate card, plugging into the original TI Peripheral Expansion Box (P-Box), or attached to a disk drive specifically intended for use with a TI. Third party expansion units often come with a disk controller already installed. The controller sells for approximately \$100, while a disk

drive, depending on type, can range from \$75 to \$200. With a P-Box, the drive does not need an external case and power supply, so the price will be slightly lower for the "bare" drive. Disk drives are usually better purchased new, unlike most computer components. Since disk drives have moving parts, they can become worn or mis-aligned with prolonged use. Make sure that a used disk drive is fully functional before you actually buy it! Other computer components without moving parts — such as the cards available for the TI, including the disk controller — can be purchased used. Malfunctions usually happen during the initial use of a new computer component, so once it has been established to be working, it can last for a long time without trouble.

Between a disk drive and Extended BASIC, you will have made a quantum leap from the original setup. Quite a few third party programs will now be available for use, and you will find programming to be much less tedious.

Still want to press on? Well, from the Extended BASIC/disk drive combination there is still lots of room to expand. The 32K Memory Expansion is another card (or plug-in unity, depending on whether or not you have a P-Box) which adds valuable capabilities to your computer. When coupled with Extended BASIC, a whole new spectrum of programs become available. With 32K expansion attached, Extended BASIC can load and run many assembly language programs, which include most of the third party fast-action arcade-type games that are found in such abundance. The TI Mini Memory module was once intended — at \$80 — to be an inexpensive alternative to the 32K Memory Expansion, but now that the 32K expansion itself is under \$100, Mini Memory is no longer economical. A few people have even managed to install the 32K memory directly into the console, for a reasonable price. And one other note — several companies have developed "512K" or "128K" cards for use with the 99/4A. In terms of available programming memory, those are actually 32K cards, but the additional memory can be used as a "RAMdisk" (pseudo-disk drive) or have other beneficial uses. 32K also allows the use of TI modules such as Logo and Editor/Assembler, which can be described in more detail in a future article.

There are some third-party word processors available that do not require the extra 32K,

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Case (PS, Video Module, CRT & Keyboard)	\$349
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Case (PS, Video Module, CRT & Keyboard)	\$399
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PCB Rev. D	\$375
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TS806 Complete + 10 Mb HD & Controller PCB	\$998
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TS806 Complete + 20 Mb HD & Controller PCB	\$1247
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TS800 Work Stations with above package	\$499, 3/\$1350
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TS816 KIT & PARTS

Case (PS, all hardware, cables)	\$275
PCB	\$350
Case & PCB combo & all docs (no tape drive)	\$599
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Case & PCB & Hard Drive & Controller	\$1499

TS802 — TS802H UPGRADE KIT

10 Mb Hard Drive, controller card, Prom & Docs	\$399
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16 BIT — 8088 CPU

TS1602 - 256K/1mb 8088 CPU, 8087 (math processor), 8089 (I/O Processor), NEC 7220 (graphics controller), supports CP/M 86, 2 - DSDD 40T floppies & hard drive.

TS1603 - 128K/256K/1mb, 8088 CPU, Supports MS-DOS & CP/M 86, 2 - DSDD 80T floppies, hard drive & mouse.

TS1605 - 98% IBM PC compatible - 128K/320K/512K, 8088 CPU, Supports all IBM PC software, includes color video, floppy controller, hard drive interface, mouse & bus extension.

TPCII - Portable version of the 1605.

TS 1602 KIT & PARTS

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TS 1603 KIT & PARTS

Same as TS 803 except PCB is	\$250
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TS 1605/1605CH Kit & Parts

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PCB (has RGB & Composite)	\$499
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Layman's Guide

continued from page 73
response to the programmer's specifications. For languages like COBOL, these generators can provide a 100 to 1 increase in the number of source lines the programmer produces in a given period.

Non-computer related activities are also benefiting from the application of AI techniques to planning and decision support. The computer's speed and the AI techniques are useful in almost any walk of life. When you cannot work any harder, you must begin to work smarter. Using the tools available within some of the newer software packages, the computer can help you plan how to get more done.

Business decisions, and other decisions too, require support. The facts must convince the people that it is a good decision. One which they can support. The "what if" began with the spreadsheets and the computer's high speed recalculation ability. With the introduction of AI this same type of investigation can be carried out with non-numeric values. Using one of the decision support packages many more variables can be considered and manipulated. Everybody's input can be considered.

By applying the same soft-

ware concept to manufacturing, the easiest and fastest way to make a part or assembly can be determined before the factory, machines or people are present. Product changes, improvements, problems and other situations can be subjected to computer analysis. This does not replace the human captains of industry, it just gives them the means to become admirals.

These programs and the computers to run them are at our level now. ARBORIST, EXPERT CHOICE, EXPERT EASE, and others are available for today's microcomputers. We can also interface with larger computers via telecommunications to solve larger problems. As you put more of your expertise and acquired knowledge into the system, you will be able to use the system more efficiently. Part of this will be learning by you and part will be learning by the system. You're both getting better.

Engineers often feel like they are being required to reinvent the wheel. Regardless of the discipline, most new projects are modifications, extensions, recombinations or innovations of something that has been done before. Using the knowledge base of an expert system, the new project specifications will provide the

inference engine with the information it needs to solve the problem. The solved problem now becomes part of the knowledge base to be used in the solution of the next problem.

This same technique is being applied to other professions. Law and medicine are two. As the use of AI in computers expands into the areas where computers are already present, we should be able to reap the benefits of this improved decision making. Whether or not we do will depend on us.

All of the computers discussed so far have been digital. They function with only two possibilities, on or off, 1 or 0. This is perfect for numerical processing. Not everything can be reduced to numbers and numerical or algorithmic formulas and logic. We think in symbols and we think faster than the most sophisticated computer yet conceived. Therefore, to gain the maximum benefit from the memory and speed of a modern computer, it must be able to process symbols.

ASCII and EBCDIC have reduced letters and numbers to 1s and 0s for digital computer use. Some functions even appear to be symbol oriented. COBOL uses words (symbols?)

continued on page 185

Ti Forum

continued from page 182

but most do. But to use the 99/4A as a word processor also requires a printer, so that information can be printed out after being composed on the screen. Many other programs, such as "database," or information storage utilities (e.g. a mailing list or recipe book stored on the computer), also function well with a printer.

Just as the disk drive requires a disk controller, though, a printer requires its own controller: an "RS232" interface. The RS232 costs less than \$100 as well, and can be found in as many forms as the disk controller can — card, add-on box, or even included inside some printers. Printers themselves can be separated into two general types: letter quality, and dot-matrix.

With a disk controller/drive,

32/128/512K memory expansion, an RS232 card, and a printer, you will have a fairly complete system. With this hardware, you can find the software you need to accomplish quite a few tasks that the other brands of computers boast so much about. The RS232, in fact, offers some interesting possibilities. Not only can the RS232 connect your computer to a printer, but it can also serve as the gate to the outside world for your computer. With the appropriate equipment, you can indeed have your computer turn your lights on and off, set your thermostat, or even run your model train set. Vacuuming the living room floor isn't as far off as it may first seem!

There is one additional possibility with the RS232: that of connecting a modem to the computer. A modem allows your \$75 TI-99/4A to use a regular phone line to "talk" to other, much-more-than-\$75 computers. With a modem, you may find a whole new dimension to your computing hobby. In an upcoming article(s), we will examine in depth the abilities that a modem can add to your computer, and the ins and outs of "telecommunications." Just when you thought you were done expanding...

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