VOLUME X, NUMBER 6 MARCH/APRIL 1989

FORTH DIMENSIONS

HIGH-LEVEL SINGLE-STEPPER

FORMATTING SOURCE CODE

TIME-KEEPING ROUTINE

CAPTURE

FORTH
DIMENSIONS

REFERENCE SECTION

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(Continued on page 37.)

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About the Forth Interest Group

The Forth Interest Group is the association of programmers, managers, and engineers who create practical, Forth-based solutions to real-world needs. Many research hardware and software designs that will advance the general state of the art. FIG provides a climate of intellectual exchange and benefits intended to assist each of its members. Publications, conferences, seminars, telecommunications, and area chapter meetings are among its activities.

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EDITORIAL

I recently got this word from Nathaniel Grossman: "It appears that a fulminating debate on Forth programming style has been waiting to erupt." Yes, that ugly monster has reared its ill-documented head again. Have you noticed how everyone approves of code with good style, but resists being saddled with coding conventions? The former is something everyone is pretty sure they already have (and therefore approve of), while the latter rub a Forth programmer's independent streak the wrong way.

Our retrospective look at last year's real-time programming convention included Jef Raskin's remark that Forth's use of parentheses is backwards. He said Forth code could be inserted parenthetically as the working part of a human-language essay that clearly describes the task being performed. In a letter to the editor printed in the same issue, Bill Kibler wrote of the continuing discussions in his company about Forth style. He described some of the real costs of code that does not conform to a standard of style.

Even before that issue was printed, Glen Haydon offered his own timely contribution to the subject. Here you will find his code to let you embed Forth programs in clearly written (knock on wood) English descriptions of their function. Have a look at Glen's example, try it on some of your own code, then let us know your reactions, opinions, and variations. Also see Peter Verhoeff's time-keeping routine for a couple of incidental contributions to the discussion of style.

* * *

If coding style seems like weak fare, perhaps you should make reservations to attend euroFORML '89 on October 13–15 in West Germany. The theme will be loosely organized around real-time applications with, typically, plenty of leeway for digression to other Forth topics. The modern Hotel Selau is in a town near the village of Forth, about 20 km. west of Nuremberg. The conference languages will be English and Forth, and the proceedings will be published (deadline for included papers: October 1). Contact Marina Kern, Roter Hahn 42, D-2000 Hamburg 72, West Germany. Then come to the original FORML conference the next month in California to share what transpired!

* * *

Like a dental probe, discussion of a sensitive issue can make one wince; the closer to the problem, the stronger the reaction. Remember the HAL 9000? In the years since that fictitious AI entity's breakdown, psychologists have confirmed that things known but not acknowledged can, indeed, hinder problem solving. This issue's FIG chapters column may make you wince, but it may move you to become part of a strong local chapter near you and, thus, part of a stronger Forth Interest Group.

As the printed voice of that membership organization, *Forth Dimensions* intends to represent its readers, not to decide for them which topics are important or how Forth should be written. The articles and essays we publish are a slice of the Forth commonwealth. The collective domain expands and shifts, and so does the material we print.

Our publishing process is meant to foster mutual benefit and cooperative effort. But this means that, more than most magazines, we rely on our readers' input. Letters to the editor are a great way to join the dialog or to offer an improvement to someone's ideas. And having an article of your own printed in these pages brings attention and recognition from an audience of intelligent peers. We welcome the contribution you may make to our next volume, and hope to hear from you soon!

—Marlin Ouverson
Editor

LETTERS

Vintage Hardware

Dear Marlin,

I was pleased to read your comments about previous-generation machines (*FD* V/5). I have, since the first day of my introduction to computing, been working with either a "home computer" (TI 99/4A) or a PG. Mine is a Kaypro I with graphics screen and double-sided disks. I can't justify the expense of a common PC, let alone something really current. That is because I have no call to ask anything of my Z80 that it can't do and do fast enough for the task at hand.

In the past three years, *FD* has published code in six articles and eight letters that I have submitted. I mention that to point out that all the code was developed on one of the computers I mentioned above (albeit only one or two were machine specific).

I see no reason for you not to publish an occasional piece that is machine specific—even if the machine is an old one. I see, as you pointed out, good reason to publish for PGs as well as for current generation PCs and beyond.

Thanks for all the good work.

Sincerely,
Gene Thomas
4300 Bowmen Road #103
Little Rock, AR 72210

Dear Marlin,

Kudos for including and eloquently justifying the Apple-specific article. I don't and haven't used one, but it was refreshing to see an alternative to the snootiness and disdain focused on us who stuck with our old stuff because it did what we wanted well enough to justify *not* rushing to buy the latest, fastest, whiz-bang *Belchfire 500* as it came out.

On the phrase, "The rest is silence." You asked Michael Perry if it came from *The Hitchhiker's Guide to the Galaxy* and he denied it. Not surprising. The line pops up in *HAIR*, sung by the chorus in "The Flesh Failures (Let the Sunshine In)". One can also find:

"O, I die, Horatio;
The potent poison quite o'er-crows my spirit:
I cannot live to hear the news from England;
But I do prophesy the election 'lights
On Fortinbras: he has my dying voice;
So tell him, with the occurrents, more and less,
Which have solicited.—The rest is silence."
[*Dies.*]

—*Hamlet*, Act V, Scene II

Regards,
Glenn Toennes

More on Behalf of Wm. Shkspr.:

Dear Mr. Ouverson:

I am writing to provide you with the original attribution for the phrase, "The rest is silence," which you mentioned in the editorial of the January/February issue. The phrase comes from near the end of Shakespeare's tragedy *Hamlet, Prince of Denmark*, Act V, Scene II, line 370 (or thereabout, depending on the version).

I hope this helps.

Sincerely,
Robert Lee Hoffpauer

[*Mr. Hoffpauer also provided the same excerpt quoted above, and further jogged my memory with Horatio's over-quoted response:* Now cracks a noble heart. Good night, sweet prince; And flights of angels sing thee to thy rest!

I knew that.—Ed.]

Forth Style

[*The following is from a letter sent to Bill Kibler in response to his letter published in our last issue; its author kindly sent me a copy as of possible interest. In light of the current discussions about Forth style, I found it illuminating and encouraging.—Ed.*]

Dear Mr. Kibler,

The latest *Forth Dimensions* arrived here yesterday, and I was able to read your letter about Forth programming style. It's, of course, not a new concern; Kim Harris wrote a major article about it many years ago, and since the start of Forth publishing there have been articles appearing regularly.

I've just written a little article which is concerned, in part, with Forth programming style. It's been submitted to *Forth Dimensions*. Of course, there is no "Forth style" as such, just as there is no unique or even dominant literary style in English. If all Forthwriters produced only code for embedded systems that had to fit into 4K, there might be a chance for a consensus style. If Forth were only for building Rapid-Files or VP-Planners, another style might appear. Then an enterprising Forth adept might produce a Forth analog of Grammatik II and impose a universal style.

Nevertheless, we all seem to agree that the principal need is to make Forth code readable by others—even by its own author. The actual mechanism for doing this may very well be implementation dependent. After all, we shouldn't expect a screen-bound Forth implementation to host a commenting style that is stream-file friendly. A Forthwriter work-

ing from floppy disks might not feel comfortable shuffling floppy disks in order to call upon elaborate shadow screens.

I don't write Forth code for a living, so I have a little leeway and the luxury to look at the artistic side of Forthwriting. Yes, I feel that writing Forth code and its commentary can be an artistic endeavor. That's not to say that the world of Forth commenting is crying out for its e.e. cummings or William Burroughs. But even technical manual writing, a well-known rite of commenting, has its good and its bad practitioners, and even a technical manual can be beautiful. Psychologists now affirm that each of us has a sense of beauty inside himself, and the current fashion allows each person free expression of that sense. Beauty and clarity are not antithetical. Let's encourage commenting as a creative activity, no less laudable than the code writing itself.

Best!
Nathaniel Grossman
Department of Mathematics
UCLA
Los Angeles, California 90024

Outa' Space
Dear Editor,

I am in need of help from my fellow FIGers. I have been working, on and off, on a program that was to produce printed circuit artwork with computer-driven routing, as well as other bells and whistles. The output is to an Epson-compatible printer or plotter. I hoped to release this program as an aid to the hardware experimenter.

My problem is that I have run into a space limitation. I am using F83 on a PC clone, and have reached the top of usable memory. I have utilized every space-saving technique I can think of, including reusing the disk buffers for a circular queue when necessary. When compiling, I use the assembler as a temporary module, and do not include the editor; but I still end up with a .COM file of >57K, not including the >150K of memory usage outside the Forth segment. The program is only partially operational, and at present consists of three text files totalling 4000 lines of code. There is still more to be added, but without more room it cannot be done.

The only solution to my problem seems to be an overlay manager for F83. Portions of the program are mutually exclusive, and would lend themselves to an overlay procedure.

If I bang my head against the wall long enough, I may be able to come up with something—but I would like to complete this project before the end of the decade. If anyone out there can help me, or is interested in the program, please drop me a line.

George Boudreau
P.O. Box 431
Kentville, Nova Scotia
Canada B4N 3X3

Korean Forth Is Natural
Sir:

I am enclosing my membership dues and photocopies of two articles my colleague, Jin-Mook Park, and I have written to introduce Korean Forth, which is a translated version of fig-FORTH. Our appreciation goes to the Forth inventor, Charles Moore, and all others who contributed to the development of Forth.

Since the syntax of Forth is similar to that of the Korean language, it is the appropriate computer language to be translated into Korean. Even though some of the other computer languages have been translated into Korean, they look strange to Koreans because of their English-like syntax. Thus, we translated fig-FORTH into Korean for Apple II+ compatibles, which have the capability to display lower-case letters. The character-generation ROM was modified to replace the lower-case patterns with those of 24 Korean characters.

There is a special notation for the Korean language. A syllable is expressed with 2–5 characters, and is normally written as a cluster character. Cluster characters are very difficult to display on the monitor, almost as difficult as displaying Chinese characters. Fortunately, Korean characters can be placed one by one as in Roman languages, with the characters in a queue. Although the latter writing method is not popular, it enabled us to implement Korean Forth with minimum modification to the hardware, i.e., replacement of the character-generation ROM.

Our first article describing Korean Forth was published by the Korean computer magazine *micro software* in September 1987. We described Forth briefly by comparing the syntaxes of computer languages like LOGO and Forth with that of the Korean language, and gave word-for-word translations of Forth words. The second, two-part, article was published in *Scientific Eastern Asian* in February and March 1988. The first part, "A Computer Understands the Korean Language" introduces the general features of Korean Forth, with printouts performed by `LIST`, `VLIST`, and `INDEX`. The second part, "Let's Program in Korean," is for the introduction of Forth programming. Screens containing definitions for a turtle graphics demonstration are listed and explained.

Forth is so simple and elegant that we, as an electronics technician and a chemist, could implement Korean Forth. Many thanks for the great works at FIG: publicizing and advancing the Forth language.

Sincerely,
Chong-Hong Pyun
Inorganic Chemistry Lab, KAIST
P.O. Box 131, DongDaeMun
Seoul, 130-600
Korea

9th Annual

1989 ROCHESTER FORTH CONFERENCE ON INDUSTRIAL AUTOMATION

June 13 – 17, 1989
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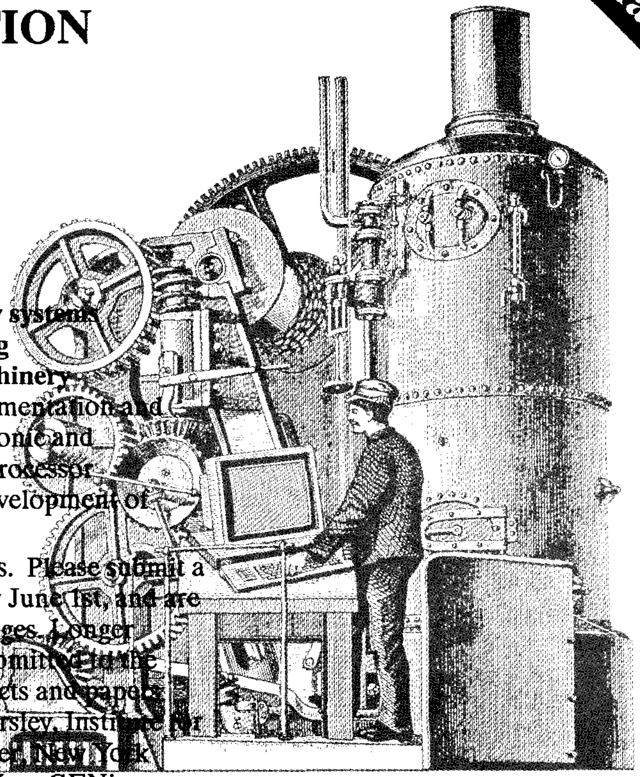
CALL FOR PAPERS



There is a call for papers on the following topics:

Forth-based sensor systems	**industrial security systems**
process control	**materials handling**
robotics	**tele-operated machinery**

In addition, papers on all aspects of Forth application, implementation and technology are being solicited. These include biomedical, avionic and space-based, business and other applications; conventional processor implementations and Forth machines; and the continuing development of Forth tools and the ANS X3J14 Forth Standard.

Papers may be presented in either platform or poster sessions. Please submit a 200 word abstract by May 15th. Papers should be received by June 1st, and are limited to a maximum of four single spaced, camera-ready pages. Longer papers may be presented at the Conference but should be submitted to the refereed Journal of Forth Application and Research. Abstracts and papers should be sent to the Conference Chairman: Lawrence P. Forsley, Institute for Applied Forth Research, Inc. 70 Elmwood Avenue, Rochester, New York 14611, or, electronically to L.Forsley on BIX or LFORSLEY on GENie.

For more information please contact the Conference Chairman or call (716)-235-0168.

REGISTRATION

The registration fee and conference services includes all sessions, meals, and the Conference papers. Lodging is available at local motels or in the UR dormitories. Registration will be from 4 – 11 PM on Tuesday, June 13th in the Wilson Commons, and from 8 AM Wednesday, June 14th in Hutchison Hall, where sessions will be held.

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Please make checks payable to the Rochester Forth Conference. Mail your registration to Rochester Forth Conference, Box A, 70 Elmwood Avenue, Rochester, NY 14611, USA.

Forth-79 & FPC

FORMATTING SOURCE CODE

GLEN B. HAYDON - LA HONDA, CALIFORNIA

There is no agreement about what constitutes a good form for source code in any language. Programming languages are too cryptic for easy understanding by the English reader. Some form of documentation is often included that, in one way or another, tries to help the reader. Having examined a variety of styles used by a number of programming languages, I have experimented with several for use with Forth programs.

In the Forth community, source code was first written in a series of blocks with occasional comments enclosed in parentheses. Further comments were sometimes included in shadow screens. These blocks or screens corresponded to the size of the screen Charles Moore had available when he first created Forth. Recently, Forth source code has been written as text files but it still can only be viewed in pages, according to the device used. Even in scrolled text, the displayed window into the text is a sort of a page. We are always back to pages.

In many journals, source code is presented in some way separate from the narrative text. The code may be inserted between lines of text as examples or included in an appendix. If one assumes that the publication of source code requires some sort of a narrative text, perhaps one should simply write all of the source code as a narrative.

Conventional source code for most languages uses some sort of enclosing symbols for comments. This technique would seem to have things backwards. What is needed is some sort of enclosing symbols to indicate what part of the narrative should be compiled. The rest of the narrative is simply easily readable documentation. (This presumes that the programmer can write English, which may not always be the case.)

With the simplicity of Forth, I have decided to see what such a technique would be like. I have selected a piece of code I wrote some time ago and published in the *FORML Proceedings 1981*. That code was written in fig-FORTH. It really needed updating to the code I presently use and seems to be a good, short piece to use as an example.

"All the information is easily located where it belongs."

The source code can be easily compiled in MVP-FORTH by a routine to bring a text file into a buffer and a slight modification to `INTERPRET`. With some slight modifications to FPC version 2.5, the same source code has compiled successfully. There are as many ways of bringing a text file into a Forth program as there are programs. I will leave that to the option of the user.

The enclosing symbols are the opening and closing braces. The opening brace is simply a text marker and requires no definition. The closing brace is an immediate Forth word to search for the next opening brace from which to start compiling again. The change required in `INTERPRET` is to point the interpreter to the text buffer in memory and to start interpreting at the first open brace.

```
: }
  BEGIN
    TIB @     >IN @
    + 1 >IN +!
    C@ 123 =
  UNTIL  ;
IMMEDIATE


: FILE-COMPILE
  TIB @ >R     >IN @ >R
  FILE-BUFFER TIB !
  0 BLK !  0 >IN !
  [COMPILE] }  <INTERPRET>
  R> >IN !     R> TIB ! ;
```

One could easily eliminate all the documentation by rewriting the source file to include only the parts enclosed within braces. This can be done with a simple filter function, which can be easily implemented in Forth. But this would defeat the purpose of including documentation.

If one develops his code as a text file, he could easily edit his code to conform with a style. And, really, the best time to do that is while the code is fresh in his head. In addition to an introductory note and an overview of the code, each function is presented in a fixed, general format of records with variable-length fields: name, narrative functional definition, implementation, tests, and comments. The specifications for a program should be a narrative description. Such a narrative might even help the programmer focus on the goals of his program. The actual names provide a label for the beginning of a variable-length block. The narrative functional definition is closely related to the implementation and should help the programmer understand his code. Test vectors are rarely included with any code or documentation, but with them one can, for example, determine that the function does what was intended, that the boundary conditions do not cause problems, that the stack depths before and after are as defined, etc. Finally, a comment should be included to suggest why some particular algorithm has been used or why some unusual code has been included.

The discipline of completing the programming job by adopting such a style would meet many common problems with understanding and maintaining code. All of the necessary information is easily located where it belongs. Also, publication is the ultimate goal of much research; why not incorporate that style in the source code and have the job done?

The serial-day-compression source code which follows is presented as an example for consideration. In the end, the style adopted is left up to the programmer and his management. Any style could be used. The important thing is that some style be adopted which serves as many functions as possible. This source code exists and works. It is not vaporware—try it!

SERIAL DAY COMPRESSION

by Glen B. Haydon

A serial day can be converted to a 16-bit value. The converted value can conserve memory space and make calculation of the period between days easy. The following algorithm is adapted from one presented in *Sky & Telescope* (April 1981, page 312), and was published in *FORML Proceedings 1981*.

The military sometimes refers to a Julian Day when they really mean a serial year day. It would take more than 16-bits to encode a Julian Day—in that form of reckoning, we are nearly up to 2,300,000 and each date includes an additional fractional part to indicate the time. Julian days also start at noon. This program provides an offset from the Julian Day, with March 1, 1952 being day 123. By beginning with March first, the leap-year day is the immediately preceding day. The time fraction is also dropped and the days are calendar days. The fractions in the original algorithm are used to calculate leap years and the variable lengths of months. They have been scaled to integer values and then truncated to give the proper values for a 16-bit Forth system.

The source is divided into four parts:

1. Two mathematical operators in addition to the program kernel are desirable.
2. Encoding a 16-bit serial day is accomplished with `?DATE` which first prompts for the input in a prescribed format, parses the input to three double-precision values with `$-N` and then these values are scaled and combined with the single function `TO.SERIAL.DAY`.
3. Decoding a 16-bit serial day is more complicated because it is necessary to determine if the year is a leap year and, accordingly, make a number of adjustments. This part leaves three values on the stack ready to be formatted for output.
4. Finally, the three decoded values can be formatted in a variety of ways of which one example is given.

Additional Mathematical Operators

`D/`

A double-precision number is divided by a single-precision unsigned number and leaves a double-precision value.

Implementation

```
{
: D/   ( d u -- d )
  SWAP OVER /MOD >R SWAP
  U/MOD SWAP DROP R> ;   }
```

Test

```
4. 2 D/ D.
```

Will print a double-precision value of 2.

Comment

The function illustrates how to write uncommon specific code for an application.

`D*`

A double-precision number is multiplied by a single-precision unsigned number to leave a double-precision value.

Implementation

```
{
: D*   ( d u -- d )
   DUP ROT *  ROT ROT U*  ROT + ;
}
```

Test

```
4. 2 D* D.
```

Will print the double-precision value 8.

Comment

The result could overflow if the original values are too large. This is not a problem in this application, so no error checking is done.

Encoding a Serial Day

`TO.SERIAL.DAY`

Convert a series of double-precision values representing the month, the day, and the year in the form MM/DD/YY to a 16-bit serial day.

Implementation

```
{
: TO.SERIAL.DAY   ( d d d -- u )
  ROT DUP 3 < IF 13 + SWAP 1 -
    ELSE 1+ SWAP THEN
  52 - 365.25 ROT D* 100 D/ DROP
  SWAP 30.6001 ROT D*  10000 D/  DROP + +
;
}
```

Test

```
3. 30. 60. TO.SERIAL.DAY
```

Should leave a single 16-bit value.

Comment

This is the heart of the encoding. No error checking is done. The result can be checked after input and reentered if necessary. The value 13 is introduced to offset the months in the calculation to begin with March.

`$-N`

Parse the next character string according to the delimiter provided, and convert it into a double-precision value.

Implementation

```
{
: $-N   ( c -- d )
   WORD 0 0 ROT CONVERT DDROP ; }
```

Test

```
: TEST
  ." Enter numerical value-> "
  PAD 10 EXPECT BL $-N  D. ;
```

Should print the value entered.

Comment

The function is a factor in parsing a date input formatted with slashes between the values and terminating with a blank.

`?DATE`

Provide a prompt to remind the user of the format for the input, and convert the input to a serial day.

Implementation

```
{
: ?DATE
  ." (MM/DD/YY) -> "
  QUERY 47 $-N  47 $-N
  BL $-N TO.SERIAL.DAY ;
}
```

Test

```
?DATE
```

Will issue the desired prompt and leave a 16-bit serial day, which can be printed with `.DATE` to be coded later.

Comment

These several routines have no error checking and some means should be provided to ensure that the intended date has been entered. There is no possible way to assure that the intended date has been input, so one might as well inspect the result and eliminate the overhead for error checking.

Decoding Routines

`YEARS`

From a serial day value, calculate a test year as a single-precision integer from which it can be determined if a leap year must be considered.

Implementation

```
{
: YEARS  ( serial-day -- test-year )
   0 100 D* 36525 D/ DROP ;
}
```

Test

`123 YEARS`

Should leave the value 0 .

Comment

Making the value a double-precision integer is needed for scaling. The truncation takes care of the leap year.

DAYS/YEARS

For a given year, calculate the number of days in that year.

Implementation

```
{
: DAYS/YEARS   ( year -- days )
   0 36525 D* 100 D/ DROP ;
}
```

Test

`123 YEARS DAYS/YEARS`

Should leave the number of days in the selected year.

Comment

The scaling avoids the need for floating point.

TEST.YEARS

From the serial day and the test year calculated above, determine the actual year and the number of remaining days.

Implementation

```
{
:  TEST.YEARS
   ( serial-day test-year -- year days )
   DDUP DAYS/YEARS - DUP 123 <
      IF DROP 1- SWAP OVER DAYS/YEARS -
      ELSE ROT DROP
      THEN  SWAP 52 + SWAP ;
}
```

Test

`123 0 TEST.YEARS`

Should convert the serial day to the year 52 and the remaining days in that year.

Comment

The number of years determined is offset to begin with 52, which in this case is the year the sample date should give.

MONTHS

From the remaining days after the test year has been removed, determine a test month.

Implementation

```
{
: MONTHS   ( days -- days test-month )
  DUP 3267963. ROT D*
  10000 D/ 10000 D/ DROP ;
}
```

Test

`123 MONTHS .S`

Should show the days and a value for a test-month.

Comment

The rather large value for determining a test month must be scaled down in two steps on a 16-bit processor.

DAYS.TO.M/D/Y

Going back to the calculation leaving years and days, calculate the actual number of months and days.

Implementation

```
{
:  DAYS.TO.M/D/Y
   ( years days -- years days months )
   MONTHS SWAP OVER
   30.6001 ROT D* 10000
   D/ DROP - SWAP DUP 13 >
      IF 13 - ROT 1+ ROT ROT
      ELSE 1- THEN ;
}
```

Test

`52 123 DAYS.TO.M/D/Y  .S`

The three values should be left on the stack ready to be output.

Comment

Again the use of double-precision integers with scaling is used rather than floating point. Note the 13 is used to gain the offset to the effective year ending at the end of February.

CONV.SERIAL

Convert a serial day to a form ready for formatting.

Implementation

```
{
:  CONV.SERIAL
   ( serial-day -- years days months )
   DUP  YEARS  TEST.YEARS
   DAYS.TO.M/D/Y ;
}
```

Test

```
123 CONV.SERIAL
```

Should complete the conversion from the serial day to 3/1/52. Try other values.

Comment

With the values left on the stack, they may be used in many ways, according to the requirements of the application.

Format and Output

```
OUT.DATE
```

Format the date values into a double-precision value, which can then be formatted with the primitive formatting tools, and finally type it.

Implementation

```
{
: OUT.DATE  ( years days months -- )
  100 * + 0 100 D* ROT 0 D+
  <# # # 47 HOLD # # 47 HOLD # # #>
  TYPE ;
}
```

Test

```
52 1 3 OUT.DATE
```

Should output the beginning date in the form 3/1/52.

Comment

A variety of other output formats could be implemented, according to the desires of the user.

```
.DATE
```

From a serial day as it may be retrieved from a database, print the date in the selected format.

Implementation

```
{
: .DATE    ( serial-day  --  )
   ?DUP
   IF CONV.SERIAL OUT.DATE
   ELSE ." 00/00/00" THEN ; EXIT
}
```

Test

```
123 .DATE
```

Should print the date 3/1/52.

Comment

The program can be rearranged to output the result in any different format, such as DD/MM/YY. If the serial day has a zero value, as in an unused zero-initialized date field, the zero date is printed without any conversion.

A HIGH-LEVEL SINGLE-STEPPER

PHILIP BACON - GAINESVILLE, FLORIDA

When a newly defined Forth word fails to produce the intended effects, the source of the difficulty can sometimes be found by a single-stepper, a program that executes the words of a colon definition one-by-one, displaying the contents of the stack and pausing at each step until a keyboard command causes it to continue.

When I switched from programming a Commodore 64 to an IBM XT, I wanted a single-stepper immediately, without waiting to learn 8088 assembly language. So I designed the single-stepper shown in screens 23–29. The basic strategy is to simulate the Forth interpreter. A variable `IP` serves as a mock instruction pointer. An array `RETURNSTACK` is used to simulate the return stack; the parameter stack simulates itself. The only Forth words that do not simulate themselves are those that manipulate the instruction pointer or the return stack in unusual ways.

```
SCR # 21
( Utilities )
: .BYTE  ( 8b --  )
  BASE @ SWAP HEX  US>D  <#  # #  #>  TYPE SPACE BASE !  ;
: .ADDRESS  ( 16b --  )
  BASE @ SWAP HEX US>D <#  # # # #  #> TYPE SPACE  BASE !  ;
: DUMP  ( addr u --  )
  OVER + OVER DO
    I OVER - 8 MOD 0= IF CR  CR I .ADDRESS 3 SPACES  THEN
    I C@ .BYTE
  LOOP
  DROP  ;

: SCAN   ' HERE OVER - DUMP  ;

                              -->


SCR # 22
( Case words )
: =IF   COMPILE OVER  COMPILE =  [COMPILE] IF  COMPILE DROP  ;
  IMMEDIATE
: FIN   COMPILE EXIT  [COMPILE] THEN  ;   IMMEDIATE

-->
```

Dissect Your Interpreter

Since different Forth interpreters behave differently, this is not a program you can just type in and run. To write a single-stepper that works for you, you will have to find out just how your Forth interpreter behaves. One way to do this is to read the source code for your Forth. An easier alternative is to run a few test words and observe the results. Here is an example of the kind of detective work to be done.

The Forth-83 words that interact with the return stack are `>R`, `R>`, `R@`, `QUIT`, `ABORT`, `ABORT"`, `EXIT`, and the run-time actions of `:`, `;`, and `;CODE`. Additional possibilities are the run-time words for `DO`, `LEAVE`, `LOOP`, and `+LOOP`. An examination of the word list for the Forth at hand turns up yet more possibilities: `2>R`, `2R>`, `;S`, `R0`, `RP@`, `RP!`, and `UNRAVEL`.

To this list of words that might need to be simulated, we must append words that use the instruction pointer in special ways. These include the words that push compiled constants to the parameter stack, and the run-time words compiled by `IF`, `ELSE`, `THEN`, `BEGIN`, `WHILE`, `REPEAT`, `AGAIN`, and `."`. In the Forth at hand, these run-time words are `LIT`, `DLIT`, `0BRANCH`, `BRANCH`, and `(.")`.

Any words in the list that are defined in terms of other words in the list do not need to be simulated. We now start probing.

The word `SCAN` (screen 21) displays the compiled form of colon definitions. In response to

```
: ALPHA  DUP ;
SCAN ALPHA
```

the following is displayed:

```
7B25  D9 05 19 05 CB 03
```

```
SCR # 23
( STEP )
 DECIMAL
VARIABLE IP
: IP+   2 IP +!  ;
: SKIP   4 IP +!  ;
VARIABLE LEVEL
VARIABLE MARK
VARIABLE RETPTR
: :RP@   RETPTR @  ;
: :RP!   RETPTR !  ;
VARIABLE :R0
CREATE RETURNSTACK   64 ALLOT
HERE :R0 !
-->


SCR # 24
( STEP )
DECIMAL
: :R@   RETPTR @  @  ;
: :R>   :R@  2 RETPTR +!  ;
: :>R   -2 RETPTR +!  RETPTR @  !  ;
: ::   IP @ DUP 2+ :>R @ 2+ IP !  2 LEVEL +!  ;
: :;S   :R>  IP !  -2 LEVEL +!  ;
: PRIMARY  IP @ @  IP+  EXECUTE  ;
: :BRANCH   IP @ 2+ @ IP !  ;
: :0BRANCH   IF SKIP ELSE :BRANCH THEN  ;
: :LIT   IP @ 2+ @  SKIP  ;
: :DLIT   IP @  2+ DUP @  SWAP 2+ @  6 IP +!  ;
: :2>R   SWAP :>R :>R  ;
: :2R>   :R> :R> SWAP  ;
-->


SCR # 25
( STEP )
HEX
: :(DO)
   IP @ 2+ @ :>R   OVER 8000 + :>R   - 8000 SWAP - :>R  SKIP  ;
: :(LOOP)   :R> 1+ DUP 8000 = IF
     DROP  :R> DROP  :R> DROP  SKIP
   ELSE  :>R :BRANCH  THEN  ;
: :(+LOOP)   :R> OVER OVER + DUP :>R 0<
   IF  0< NOT SWAP 0< NOT  ELSE  0< SWAP 0<  THEN   AND
   IF  :R> DROP :R> DROP :R> DROP SKIP  ELSE  :BRANCH  THEN  ;
: :LEAVE   :R> DROP  :R> DROP  :R> IP !  ;
: :I   :R> DUP :R@ + SWAP :>R  ;
: :J   RETPTR @  DUP 6 + @  SWAP 8 + @  +  ;
: :(;CODE)   :R> LATEST NAME> !  -2 LEVEL +!  ;
' DUMP @ CONSTANT DOCOL
        DECIMAL  -->
```

```
SCR # 26
( STEP )
: PACE    IP @ @
      ['] R@        =IF   IP+ :R@       FIN
      ['] R>        =IF   IP+ :R>       FIN
      ['] >R        =IF   IP+ :>R       FIN
      ['] ;S        =IF   :;S           FIN
      ['] EXIT      =IF   :;S           FIN
      ['] BRANCH    =IF   :BRANCH       FIN
      ['] 0BRANCH   =IF   :0BRANCH      FIN
      ['] (DO)      =IF   :(DO)         FIN
      ['] (LOOP)    =IF   :(LOOP)       FIN
      ['] (+LOOP)   =IF   :(+LOOP)      FIN
      ['] LEAVE     =IF   :LEAVE        FIN
      ['] I         =IF   IP+ :I        FIN
      ['] J         =IF   IP+ :J        FIN
      ['] (;CODE)   =IF   :(;CODE)      FIN          -->
```

```
SCR # 27
( STEP )
      ['] LIT       =IF   :LIT          FIN
      ['] DLIT      =IF   :LIT          FIN
      ['] 2>R       =IF   :2>R          FIN
      ['] 2R>       =IF   :2R>          FIN
      ['] R0        =IF   :R0           FIN
      ['] RP@       =IF   :RP@          FIN
      ['] RP!       =IF   :RP!          FIN
      ['] QUIT      =IF   QUIT          FIN
      @ DOCOL  =  IF  ::  ELSE  PRIMARY  THEN  ;

-->
```

```
SCR # 28
( STEP )
  HEX
: CR   CR 0 OUT !  ;
: HTAB   ( n -- )
  DUP OUT @ <  IF  CR  ELSE  OUT @ -  THEN  SPACES  ;
: U.S   DEPTH  IF  0 DEPTH 2- DO I PICK U. -1 +LOOP  THEN  ;
: DISPLAY   18 HTAB  ." ( "  U.S   CR
  IP @ DUP .ADDRESS  LEVEL @ SPACES  @ >NAME ID.  ;
: SELECT
  -1 SWAP
    51 ( Q ) =IF  DROP QUIT             FIN
    53 ( S ) =IF  LEVEL @  2+  MARK !  FIN
    52 ( R ) =IF  LEVEL @      MARK !  FIN
    43 ( C ) =IF  LEVEL @  2-  MARK !  FIN
    DROP           DROP 0  ;              DECIMAL  -->
```

```
SCR # 29
( STEP )
 DECIMAL
VARIABLE ACTION
: STEP
  '   ACTION !  ACTION IP !  0 LEVEL !
  :R0 @  :RP!
  BEGIN
    PACE  [ ACTION 2+ ] LITERAL  IP @  -
  WHILE
    LEVEL @  MARK @  >  NOT  IF
      DISPLAY  BEGIN  KEY SELECT  UNTIL
    THEN
  REPEAT  ;

;S
```

By using ' we find that the compilation address of DUP is 0519 (hex), and the compilation address of ;S is 03CB. Comparison of these values with the compiled form of ALPHA suggests that compilation addresses are compiled in low-high byte order, that every colon definition is prefaced by the bytes D9 and 05, and that ; compiles ;S.

The next test requires two words:

```
: BETA   R> DUP
  .ADDRESS >R ;

: GAMMA   BETA ;
```

The output of SCAN GAMMA is:

```
7B46  D9 05 32 7B CB 03
```

The compilation address of BETA is 7B32. Execution of GAMMA prints 7B4A. This shows that when the interpreter encounters a colon definition, it adds two to the value of the instruction pointer before pushing the value to the return stack. Our simulator must treat IP and RETURNSTACK similarly.

The next word is used to find out how branches are compiled.

```
: DELTA
  IF DUP ELSE SWAP THEN ;
```

The output of SCAN DELTA is:

```
7B54 D9 05 8A 01 60 7B 19 05
7B5C 77 01 62 7B 08 05 CB 03
```

The compilation addresses of BRANCH and 0BRANCH are 0177 and 018A, respectively. Knowing this, we can see that IF compiles 0BRANCH followed by a destination address, and that ELSE compiles BRANCH followed by a destination address. Our simulation of 0BRANCH must put the compiled address into IP if the top of the parameter stack is zero; otherwise, the value of IP must be incremented by four. The simulation of BRANCH must put the compiled address into IP.

The next test word exhibits the compiled form of a DO loop.

```
: EPSILON
  DO LEAVE LOOP ;
```

The output of SCAN EPSILON is:

```
7B6E D9 05 E0 01 7A 7B DF 03
7B76 A8 01 74 7B CB 03
```

The compilation address of (DO) is 01E0, that of LEAVE is 03DF, and that of (LOOP) is 01A8. We see that (DO) is followed by the address of the loop exit, and (LOOP) is followed by the address of the first location within the loop.

Execution of the next test word shows that (DO) pushes the DO loop parameters to the return stack.

```
: OMEGA
  5 2 DO
    CR I .
    R> DUP .ADDRESS
    R> DUP .ADDRESS
    R> DUP .ADDRESS
    >R >R >R
  LOOP ;
```

Execution of OMEGA yields:

```
2 7FFD 8005 7BB2
3 7FFE 8005 7BB2
4 7FFF 8005 7BB2
```

At run time, (DO) pushes three items to the return stack: the address of the loop exit, the sum of 8000 and five, and the value 8000 - (5 - 2). Each time (LOOP) is encountered, the value on the top of the return stack is incremented by one. When the result is 8000 (hex), the loop is exited. Execution of I produces the sum of the first two values on the top of the return stack. When LEAVE executes, control goes to the third address from the top. Our simulations of these words must treat RETURNSTACK similarly.

If FIVE is defined as:

```
: FIVE   5 ;
```

execution of SCAN FIVE yields

```
7B24 D9 05 42 01 05 00 CB 03
```

Since 0142 is the compilation address of LIT, we see that the simulation of LIT must push the value contained in the two bytes following LIT, and increment that value of IP by four.

You might imagine that (.")—which is the run-time word for ."—would need to be treated something like

`LIT`. But in this version of Forth, `(.")` is a compound word, and therefore can simulate itself.

Using the Single-Stepper

Once we have simulations for the words that need them, we put all in a word called `PACE`. Suppose `IP` contains an address at which the compiling address of a Forth word resides. If `PACE` is invoked and the Forth word is not a compound word, that word is executed. If the word is defined by a colon definition, the address of the first word in the colon definition is put into `IP` and the value of a variable `LEVEL` is the principal building block for the single-stepper `STEP`, which is used as follows.

Suppose you have defined a Forth word `SHAKY` that doesn't work as you intend. Put any parameters needed by `SHAKY` onto the parameter stack and type `STEP SHAKY`. The contents of the parameter stack and the first word in the definition of `SHAKY` will be displayed. If you now press the `R` key, the displayed word will be executed, a new picture of the stack will be shown, and the next word to be executed will be displayed. Press the `R` key repeatedly, until the word that produces the bad output (`TROUBLE`, say) is executed. Quit (by pressing `Q`) and start over. But this time, when `TROUBLE` is displayed, do not execute it by pressing `R`; instead, press `S`. If `TROUBLE` is a compound word, the first word in its definition is displayed. The descent into the definition of `TROUBLE` is indicated by extra indentation. To further localize the source of your difficulties, step through the definition of `TROUBLE` by repeatedly pressing `R`. To complete the execution of whatever word you are currently stepping through, press `C`.

Philip Bacon teaches mathematics at the University of Florida. He has used a homebrew Forth to prototype assembly language programs for the Commodore 64.

CAPTURE!

BRUCE T. NICHOLAS - RALEIGH, NORTH CAROLINA

After studying several books about the Forth programming language, I decided the only way to really learn Forth would be to attempt to write a program using it. About this time, my eight-year-old son wanted me to help him write a program to draw on the screen. We first wrote a BASIC program similar to the familiar Etch-a-Sketch, then I decided to translate it into Forth. This was easier than I thought, so I decided to write a more difficult program.

I took a BASIC program and rewrote it to run with Laxen & Perry's F83. This is a public-domain implementation, available on many bulletin boards. I got my copy from PC-SIG (1030 E. Duane, Suite J, Sunnyvale, CA 94086; the two-disk set 263 and 264).

In this game, you may choose to play against up to three opponents, deadly beasts which stalk you as you try to trap them while staying out of their reach. This version of the game is neither an elegant nor an efficient translation into Forth, but it is faster than the BASIC version. In fact, I had to put a timing loop into the Forth code to slow the game down. I built in nine different speeds (not in the original game), as well as three levels of difficulty.

When the game is played, a title page shows which keys move your piece around the screen. Use the keypad, as shown below, to move. Pressing 8 moves your screen marker up, 1 moves it diagonally down to the left, etc. Press any other key to stop moving.

Obstacles are placed randomly on the screen. You can push these around, but the beasts cannot. Your job is to build walls completely enclosing the beasts. The game ends when none of the beasts can move (or if you get eaten).

7	8	9
4	5	6
1	2	3

Keyboard "joystick"

Programming Notes

Obstacles, beasts, and your marker are placed randomly on the text screen. The program pauses to allow the player to study the game board and plan a strategy.

In the highest level of difficulty, each beast gets a chance to move every time you do. At lower levels you are given extra moves.

"I had to put in a timing loop to slow the game."

Screens one through five contain general-function words. The game itself begins on screen six. Screens seven and eight display the title and get the required input to play the game. Screen nine sets up a white-on-blue game board and outlines the board with double box characters.

Screens 12–16 contain the words that move the marker around the board.

`MOVE_HERO` (screen 17) moves your piece around the board, and pushes the obstacles.

`MOVE_BEAST` (screen 18) contains the routine for moving the beasts. The beasts follow you, but not perfectly. They have to be able to move around obstacles, even if that entails backing up. After checking to see if the beast is right next to you (too bad for you!), a value of -1, 0, or 1 is selected for X and Y. This will modify the beast's position coordinates so that there is a higher probability of it stepping toward you than away from you. A check is made in the chosen location for an ASCII 32 (space). If an obstacle or another beast is found there, the beast searches in adjacent squares for a favorable place to move. When no beasts can move, you have won the game. `LOSE?` and `WIN?` (screen 19) check for these conditions and take the appropriate action.

Code on screen 23 will create a CAPTURE.COM file. This eliminates the need to enter Forth and load the program each time you wish to play.

During the game, the elapsed time is displayed.

Credits and Requirements

Capture is designed to run on black-and-white or color monitors in 80-column mode. This version was written for the IBM PC.

The original version of this game was called Trap'Em, written by Rob Smythe in Applesoft BASIC for the Apple II computer, and was published in *Nibble* (vol. 2, no. 4, 1981).

0

```
\ CAPTURE                                             BTN 04-14-1988

This game is based on the program originally written in

Applesoft BASIC by Rob Smythe for the Apple II and published

in NIBBLE magazine Vol.2/No.4/1981.  I wrote this version of

the program as a learning experience.  It is written using

the public domain version of FORTH - F83 by Perry & Laxen.



                Bruce T. Nicholas
```

24

```
\ CAPTURE                                             BTN 04-14-1988

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the public domain version of FORTH - F83 by Perry & Laxen.



                Bruce T. Nicholas
```

1

```
\ CAPTURE - Load screen                               BTN 04-16-1988

: CLS    DARK  ;

   CLS

   2 LOAD   CR  .( Time words loaded        )    \ Timer
   3 LOAD   CR  .( Code words loaded        )    \ Code words
   4 LOAD   CR  .( Random generator loaded  )    \ Random
   5 LOAD   CR  .( Matrix words loaded      )    \ Matrix
 6 22 THRU  CR  .( CAPTURE loaded           )    \ Load CAPTURE
  23 LOAD   CR  .( CAPTURE.COM file built   )    \ Applic. file
            CR
            CR  .( Type  GAME  to play or   )    \ Play game
            CR  .( type BYE to exit Forth   )
            CR  .( and then type CAPTURE    )
```

25

```
\ CAPTURE - Load screen                               BTN 04-16-1988

: CLS        Clear the screen and home cursor



    2 LOAD   Time words loaded
    3 LOAD   Code words loaded
    4 LOAD   Random generator loaded
    5 LOAD   Matrix words loaded
 6 22 THRU   CAPTURE loaded
   23 LOAD   CAPTURE.COM application file built and saved
```

2

```
\ TIME OF DATE WORDS                                  BTN 04-14-1988

VARIABLE  HOURS   VARIABLE  MINUTES    VARIABLE  SECONDS
: @HRS   HOURS  @  ;
: @MIN   MINUTES @  ;
: @SEC   SECONDS @  ;

CODE  GETIME   AX POP  AL AH MOV  33 INT  CX PUSH  DX PUSH
       AH AH SUB  AL PUSH   NEXT  END-CODE

: TIME@   44 GETIME  DROP 256 /MOD  ROT 256 /MOD ;

: TIME!    TIME@  HOURS !  MINUTES !  SECONDS !   DROP  ;

: TIME   TIME@  60 * + 60 * +  @HRS 60 * @MIN + 60 * @SEC + -
       60 /MOD  . ." Minutes and " . ." Seconds " DROP ;
```

26

```
\ TIME OF DATE WORDS                                  BTN 04-18-1988

                      Variables used by timer.
: @HRS                Fetch the hours.
: @MIN                Fetch the minutes.
: @SEC                Fetch the seconds.

CODE  GETIME          Get the time of day.


: TIME@               Get the time.

: TIME!               Store the time in Hours, Minutes and seconds.

: TIME                Get the time and format into minutes and
                      seconds to show elapsed time during game.
```

3

```
\ CODE WORDS - POKE, PEEK, EQUIP, CGA?          BTN 04-20-1988

CODE   POKE   (S byte segment address -- )
   BX POP  ES POP  AX POP  ES:  AL 0 [BX] MOV  NEXT  END-CODE
CODE   PEEK   (S segment address -- byte )
   AX AX SUB  BX POP  ES POP  ES: 0 [BX] AL MOV 1PUSH END-CODE
CODE   EQUIP   (S -- equip )
   17  INT  1PUSH  END-CODE        \ list of hardware on stack

HEX
: CGA?  (S -- video-buffer-address attrib )      \ B&W or Color
   EQUIP   30 AND 30 = IF 0B000 ( B/W MONITOR) 70 ( ATTRIB )
   ELSE 0B800 ( COLOR MONITOR)  71 ( ATTRIB ) THEN  ;
DECIMAL
            CGA?  CONSTANT ATTRIB
                  CONSTANT SEGMENT
```

27

```
\ CODE WORDS - POKE, PEEK, EQUIP, CGA?          BTN 04-14-1988

CODE   POKE      Used to put a byte of data to the Video screen.

CODE   PEEK      Used to get a byte of data from the screen.

CODE   EQUIP     Puts a list of hardware on the stack.  Used to
                 determine the type of attached monitor.


: CGA?           Used to set the memory location of the attached
                 video monitor.
```

4

```
\ RANDOM GENERATOR - RAND, RANDOM, EKEY, WKEY     BTN 04-20-1988

   VARIABLE   SEED   TIME@ + + *   SEED   !

: RAND   (S -- random no. )
   SEED @  5421 *  1+  DUP  SEED  !  ;

: RANDOM   (S n -- random no. )
   RAND  FLIP  SWAP  MOD  ;

: EKEY   KEY  DUP 0= IF  DROP  KEY THEN ;       \ Extended keys

: WKEY   EKEY 0= IF DROP THEN ;
```

28

```
\ RANDOM GENERATOR - RAND, RANDOM, EKEY, WKEY     BTN 04-18-1988

VARIABLE   SEED    Used as a seed for the random generator.

: RAND             Used for the random generator.

: RANDOM           Random number generator.

: EKEY             Reads the extended keyboard keys.

: WKEY             Wait for any key press.
```

5

```
\ MATRIX WORDS - MATRIX, ELEMENT, FIND-LENGTH etc BTN 04-14-1988

: MATRIX     (S 2 bytes per entry )
   CREATE  (S #rows #columns -- )
     2DUP  , ,                  \ Remember the dimensions
     * 2* ALLOT   ;             \ #rows * #cols elements
: ELEMENT (S row# col#  ^matrix -- ^element )
  DUP >R @
  ROT 2* * SWAP 2* +
  R>  4 +  +  ;

24 80 MATRIX SCREEN
: FIND-LENGTH   (S address -- length )
   SCREEN DUP 2+ @ SWAP @ *   ;
: FILL-ARRAY    (S array-index --)
    0 DO I 2* 0 I SCREEN ELEMENT ! LOOP ;
```

29

```
\ MATRIX WORDS - MATRIX, ELEMENT, FIND-LENGTH etc BTN 04-18-1988

: MATRIX              Create a two dimensional array.



: ELEMENT             Locate any data in the matrix.




24 80 MATRIX SCREEN   Build data image of the screen.
: FIND-LENGTH         Find the length of the data matrix.

: FILL-ARRAY          Fill the matrix with data.
```

```
6
\ CAPTURE - Variables                              BTN 04-14-1988

 VARIABLE  LEVEL      VARIABLE  SPEED     VARIABLE  #BEASTS
 VARIABLE  END        VARIABLE  XKEY      VARIABLE  CNT
 VARIABLE  X          VARIABLE  Y         VARIABLE  WIN
 VARIABLE  LOSE       VARIABLE  DIFFCNT   VARIABLE  ANOTHER

        0  XKEY  !          0  CNT   !          0  Y      !
        1  END   !          0  X     !          0  WIN    !
        1  LOSE  !          0  ANOTHER !

   CREATE    H   8  ALLOT
   CREATE    V   8  ALLOT
```

```
30
\ CAPTURE - Variables                              BTN 04-14-1988

Variables used in the program and their initial value.
```

```
7
\ CAPTURE - TITLE & INSTRUCTIONS                   BTN 04-16-1988

: TITLE    11  1 AT ."  C A P T U R E"
            0  4 AT ."  Trap the beasts before they get you!"
            3  6 AT ."  Box them in completely to win."
            0  8 AT ."  Use the numeric keypad to move HERO." ;
: KEYS     11 11 AT ."  7          9  " 18 11 AT 30 EMIT
           11 12 AT ."    .   |   .    "
           11 13 AT ."      . | .      "
           11 14 AT ."  ----   ----   " 12 14 AT 17 EMIT
           11 15 AT ."      . | .      " 24 14 AT 16 EMIT
           11 16 AT ."    .   |   .    "
           11 17 AT ."  1          3  " 18 17 AT 31 EMIT
            3 20 AT ."  Tap any other key to stop HERO."
            3 22 AT ."  Press ESC key to quit anytime."   ;
: CONTINUE  5 24 AT ."  Press any KEY to continue."  WKEY  ;
```

```
31
\ CAPTURE - TITLE & INSTRUCTIONS                   BTN 04-18-1988

: TITLE         Display  the title page on the screen.

: KEYS          Show the cursor control keys.

: CONTINUE      Pauses the display so the screen can be read.
```

```
8
\ CAPTURE - TITLE & INSTRUCTIONS                   BTN 04-20-1988

: INVERSE   3  0 DO
        30  0 DO ATTRIB SEGMENT   23 I + 160 J * + POKE 2 +LOOP
            LOOP ;
: INVERSE1  9  0 DO
        34  0 DO ATTRIB SEGMENT 1621 I + 160 J * + POKE 2 +LOOP
            LOOP ;

: ASK   KEY 48 - 1 MAX  MIN DUP 48 + EMIT ;
: #BEASTS?      0 20 AT ."  Number of beasts ( 1, 2, or 3 ) ? "
          3 ASK  #BEASTS ! ;
: DIFFICULTY?   0 22 AT  ."  Level of difficulty ( 1 to 3 Easies
t ) ? "  3 ASK  LEVEL ! ;
: SPEED?        0 24 AT  ."  Set speed ( 1 to 9 Slowest ) ? "
          9 ASK  SPEED !  36 20 AT ;
```

```
32
\ CAPTURE - TITLE & INSTRUCTIONS                   BTN 04-18-1988

: INVERSE       Reverse video for title.

: INVERSE1      Reverse video for keypad area.

: ASK           Read the key and limit the input.
: #BEASTS?      Store the number of beasts to be used.

: DIFFICULTY?   Store the difficulty level to be used.

: SPEED?        Store the speed of the game.
```

9

```
\ CAPTURE - BORDERS and COLOR                    BTN 04-14-1988

: THERE   (S h v -- )
  SWAP  SEGMENT  -ROT  SCREEN  ELEMENT @ ;

: T&B    79 1 DO 205  I  0 THERE POKE
                 205  I 23 THERE POKE LOOP ;
: SIDES  23 1 DO 186  0  I THERE POKE
                 186 79  I THERE POKE LOOP ;
: CORNERS        201  0  0 THERE POKE
                 200  0 23 THERE POKE
                 187 79  0 THERE POKE
                 188 79 23 THERE POKE  ;

: BORDERS        T&B SIDES CORNERS ;
: COLOR   3840 1 DO 23 SEGMENT I  POKE 2 +LOOP ;
```

33

```
\ CAPTURE - BORDERS and COLOR                    BTN 04-14-1988

: THERE      Location to put the screen data.


: T&B        Draw the top and bottom of the display box.

: SIDES      Draw the right and left sides of the display box.

: CORNERS    Draw the four corners of the display box.




: BORDERS    Draws a complete box around the border.
: COLOR      Set screen attribute bytes to white on blue.
```

10

```
\ CAPTURE - OBSTACLES,  BEAST                    BTN 04-14-1988

: HORZ   78 RANDOM 1+ ;
: VERT   22 RANDOM 1+ ;
: HB     H  CNT @ 2* + ;          ( horiz index to each beast )
: VB     V  CNT @ 2* + ;          ( vert  index to each beast )

: OBSTACLES    400 0 DO  177  HORZ  VERT  THERE POKE  LOOP ;

: VACANT?    BEGIN  HORZ DUP HB ! VERT DUP VB ! THERE PEEK
             BL = UNTIL ;

: BEAST    -1 CNT !  BEGIN  1 CNT +!    VACANT?
     200 0 DO   BL  HB @          VB @ THERE POKE
                42  HB @          VB @ THERE POKE  LOOP
                CNT @ #BEASTS @ 1- = UNTIL  ;
```

34

```
\ CAPTURE - OBSTACLES,  BEAST                    BTN 04-14-1988

: HORZ         Generate random number for horizonal location.
: VERT         Generate random number for vertical  location.
: HB           Horizonal index to each beast.
: VB           Vertical index to each beast.

: OBSTACLES    Place obstacles on the screen.

: VACANT?      Check if the location is empty.


: BEAST        Place the number of beasts wanted on the screen.
```

11

```
\ CAPTURE - HERO and Misc                        BTN 04-14-1988

: V+1   V  8 + @ 1+ ;                     \ Index 4 2*
: V-1   V  8 + @ 1- ;
: H+1   H  8 + @ 1+ ;
: H-1   H  8 + @ 1- ;
: V0    V  8 + @    ;
: H0    H  8 + @    ;
: H1    H  8 +      ;
: V1    V  8 +      ;

: OPOKE    H0 V0 THERE POKE ;

: HERO       4 CNT !   VACANT?
   200 0 DO         BL  OPOKE
                     2  OPOKE   LOOP   ;
```

35

```
\ CAPTURE - HERO and Misc                        BTN 04-14-1988

: V+1        Vertical location  + 1.
: V-1        Vertical location  - 1.
: H+1        Horizonal location + 1.
: H-1        Horizonal location - 1.
: V0         Vertical location.
: H0         Horizonal location.
: H1         Horizonal location.
: V1         Vertical location.

: OPOKE      Put the data to the screen where it is.

: HERO       Look for a place to put our HERO.
```

```
   12                                                                  36
\ CAPTURE - UP^, DOWN                           BTN 04-14-1988 \ CAPTURE - UP^, DOWN                        BTN 04-14-1988

: VACANT   DUP  BL = ;                                           : VACANT          Is location blank?
: UP^      V0   0  DO                                            : UP^             Move one space up.
                   H0      V-1  I - THERE PEEK  VACANT IF
  OPOKE   177      H0      V-1  I - THERE POKE
            2      H0      V-1      THERE POKE
                           V-1 V1 ! LEAVE ELSE
          42 = IF  LEAVE   THEN     THEN  LOOP ;

: DOWN     23 V0 - 0 DO                                          : DOWN            Move one space down.
                   H0      V+1 I +  THERE PEEK  VACANT  IF
  OPOKE   177      H0      V+1 I +  THERE POKE
            2      H0      V+1      THERE POKE
                           V+1 V1 ! LEAVE ELSE
          42 = IF  LEAVE   THEN     THEN  LOOP ;

   13                                                                  37
\ CAPTURE - LEFT, RIGHT                         BTN 04-14-1988 \ CAPTURE - LEFT, RIGHT                      BTN 04-14-1988

: LEFT     H0    0 DO                                            : LEFT       Move one space left.
                   H-1 I -  V0      THERE PEEK  VACANT IF
  OPOKE  177       H-1 I -  V0      THERE POKE
           2       H-1      V0      THERE POKE
                   H-1 H1 !         LEAVE ELSE
         42 = IF  LEAVE    THEN     THEN  LOOP ;

: RIGHT    79 H0  - 0 DO                                         : RIGHT      Move one space right.
                   H+1 I +  V0      THERE PEEK  VACANT IF
  OPOKE  177       H+1 I +  V0      THERE POKE
           2       H+1      V0      THERE POKE
                   H+1 H1 !         LEAVE ELSE
         42 = IF  LEAVE    THEN     THEN  LOOP ;


   14                                                                  38
\ CAPTURE - UP_LEFT, UP_RIGHT                   BTN 04-14-1988 \ CAPTURE - UP_LEFT, UP_RIGHT                BTN 04-14-1988

: UP_LEFT      V0 0 DO                                           : UP_LEFT     Move one space up and one space left.
                   H-1 I -  V-1 I -  THERE PEEK  VACANT IF
  OPOKE  177       H-1 I -  V-1 I -  THERE POKE
           2       H-1      V-1      THERE POKE
                   H-1 H1 ! V-1 V1 ! LEAVE ELSE  DUP
         42 = IF  DROP     LEAVE    THEN
        186 = IF  LEAVE    THEN     THEN  LOOP ;
: UP_RIGHT     V0 0 DO                                           : UP_RIGHT    Move one space up and one space right.
                   H+1 I +  V-1 I -  THERE PEEK  VACANT IF
  OPOKE  177       H+1 I +  V-1 I -  THERE POKE
           2       H+1      V-1      THERE POKE
                   H+1 H1 ! V-1 V1 ! LEAVE ELSE  DUP
         42 = IF  DROP     LEAVE    THEN
        186 = IF  LEAVE    THEN     THEN  LOOP ;
```

```
   15
\ CAPTURE - DOWN_LEFT, DOWN_RIGHT                BTN 04-14-1988
: DOWN_LEFT     23 V0 - 0 DO
                   H-1 I -  V+1 I +  THERE PEEK  VACANT IF
   0POKE  177      H-1 I -  V+1 I +  THERE POKE
            2      H-1      V+1      THERE POKE
                   H-1 H1 ! V+1 V1 ! LEAVE ELSE  DUP
          42 = IF  DROP     LEAVE    THEN
         186 = IF  LEAVE    THEN     THEN  LOOP ;

: DOWN_RIGHT    23 V0  -  0 DO
                   H+1 I +  V+1 I +  THERE PEEK  VACANT IF
   0POKE  177      H+1 I +  V+1 I +  THERE POKE
            2      H+1      V+1      THERE POKE
                   H+1 H1 ! V+1 V1 ! LEAVE ELSE  DUP
          42 = IF  DROP     LEAVE    THEN
         186 = IF  LEAVE    THEN     THEN  LOOP ;
```

```
   39
\ CAPTURE - DOWN_LEFT, DOWN_RIGHT                BTN 04-14-1988
: DOWN_LEFT     Move one space down and one space left.







: DOWN_RIGHT    Move one space down and one space right.
```

```
   16
\ CAPTURE - FUNCTION                             BTN 04-14-1988

: FUNCTION
   DUP  72 = IF DROP UP^        EXIT THEN
   DUP  80 = IF DROP DOWN       EXIT THEN
   DUP  77 = IF DROP      RIGHT EXIT THEN
   DUP  75 = IF DROP      LEFT  EXIT THEN
   DUP  71 = IF DROP UP_LEFT    EXIT THEN
   DUP  73 = IF DROP UP_RIGHT   EXIT THEN
   DUP  79 = IF DROP DOWN_LEFT  EXIT THEN
   DUP  81 = IF DROP DOWN_RIGHT EXIT THEN
   DUP  27 = IF DROP 0 END !    EXIT THEN
   DROP  2 0POKE ;
```

```
   40
\ CAPTURE - FUNCTION                             BTN 04-14-1988

: FUNCTION     Check for the cursor key pressed and move
               accordingly.
```

```
   17
\ CAPTURE - MOVE_HERO and Misc                   BTN 04-14-1988

: MOVE_HERO
      KEY? IF EKEY DUP XKEY ! ELSE XKEY @ THEN  FUNCTION  ;

: Y=0    4 RANDOM 1- 2/  Y ! ;

: X=0    4 RANDOM 1- 2/  X ! ;

: Y<>0     0> IF -1 Y ! ELSE  1  Y !  THEN  100 RANDOM  DUP
          60 < IF DROP   ELSE
          75 > IF 0 Y !  ELSE  Y @ NEGATE Y ! THEN THEN ;

: X<>0     0> IF -1 X ! ELSE  1  X !  THEN  100 RANDOM  DUP
          70 < IF DROP   ELSE
          80 > IF 0 X !  ELSE  X @ NEGATE X ! THEN THEN ;
```

```
   41
\ CAPTURE - MOVE_HERO and Misc                   BTN 04-14-1988

: MOVE_HERO    Move the HERO.  He can push obstacles.


: Y=0          Generate random number if Y equals 0.

: X=0          Generate random number if X equals 0.

: Y<>0         Generate random number if Y does not equal 0.



: X<>0         Generate random number if X does not equal 0.
```

18

```
\ CAPTURE - MOVEB, MOVE_BEAST, DELAY & SET_LEVEL  BTN 04-14-1988

: MOVEB  HB @  H0 - DUP 0= IF DROP X=0  ELSE X<>0 THEN
        VB @  V0 - DUP 0= IF DROP Y=0  ELSE Y<>0 THEN
              HB @ X @ +  VB @ Y @ +   THERE PEEK
  BL = IF BL  HB @        VB @         THERE POKE
           42  HB @ X @ +  VB @ Y @ +   THERE POKE
              HB @ X @ +  HB !
              VB @ Y @ +  VB !  THEN ;

: MOVE_BEAST   -1 CNT !  BEGIN  1 CNT +!  MOVEB
    CNT @ #BEASTS @ 1- = UNTIL ;

: DELAY     25 SPEED @ 9 * *  0  DO  LOOP ;     \ Speed of game

: SET_LEVEL   DIFFCNT DUP @ 1- DUP ROT  ! ;
```

42

```
\ CAPTURE - MOVEB, MOVE_BEAST, DELAY & SET_LEVEL  BTN 04-14-1988

: MOVEB          Move the beasts to an empty space.








: MOVE_BEAST     Move the beasts.  They cannot move obstacles,
                 but must move around them.

: DELAY          Speed of game loop.

: SET_LEVEL      Set game difficulty level.
```

19

```
\ CAPTURE - LOSE? and WIN?                      BTN 04-14-1988

: LOSE? -1 CNT ! BEGIN  1 CNT +! 3 0 DO   3 0 DO
     HB @  I 1- +  VB @  J 1- + THERE PEEK
     2 = IF  0 END !  AT 4 24 ." "
     4 24 AT ." YOU LOSE " 0 LOSE ! LEAVE ELSE 1 LOSE !
     THEN LOOP LOOP
     CNT @ #BEASTS @ 1- = UNTIL  ;

: WIN? -1 CNT ! 0 WIN ! BEGIN  1 CNT +! 3 0 DO  3 0 DO
     HB @  I 1- +  VB @  J 1- + THERE PEEK
     32 = IF  LEAVE ELSE 1 WIN +!   THEN LOOP LOOP
     CNT @ #BEASTS @ 1- = UNTIL  WIN @ #BEASTS @ 9 * =
     IF 4 24 AT ." YOU WIN " 0 END ! THEN ;
```

43

```
\ CAPTURE - LOSE? and WIN?                                BTN 04-14-1988

: LOSE?      Check for loosing the game.






: WIN?       Check for winning the game.
```

20

```
\ CAPTURE - Y/N, TELL                           BTN 04-15-1988

: Y/N   BEGIN  KEY UPC DUP 78 = IF  1 ANOTHER ! DROP EXIT THEN
          89 = IF -1 ANOTHER !  THEN  ANOTHER @ 0 <> UNTIL ;

: TELL
   CLS   TITLE   INVERSE                  \ Instructions,
   KEYS   INVERSE1                        \ high-light
   CONTINUE  0 24 AT  32 SPACES           \ and
   #BEASTS?  DIFFICULTY?   SPEED?         \ initialization
   FIND-LENGTH   FILL-ARRAY    ;          \ routine
```

44

```
\ CAPTURE - Y/N, TELL                                     BTN 04-14-1988

: Y/N         Check for a YES or NO answer.


: TELL        Display the instructions and ask for
              number of beasts, difficulty level
              and speed of play.
```

```
   21
\ CAPTURE - PLAY                                      BTN 04-15-1988

: PLAY
   1 END !   0 XKEY !  0 ANOTHER !  CLS      \ Draw playing
   COLOR  BORDERS  OBSTACLES  BEAST  HERO    \ field
   CONTINUE   0 24 AT 32 SPACES  TIME!
   LEVEL @   DIFFCNT !
   BEGIN  DELAY  MOVE_HERO                   \ Speed of game
     SET_LEVEL  0= IF MOVE_BEAST LEVEL @     \ Difficulty
     DIFFCNT ! THEN LOSE?  LOSE @            \ and move/lose
     0= IF ELSE WIN? THEN 50 24 AT TIME      \ win
     END @ 0= UNTIL   20 24 AT        ;      \ End game
```

```
   45
\ CAPTURE - PLAY                                      BTN 04-14-1988

: PLAY      Draw the playing board, place the
            obstacles, the beasts and the HERO,
            then play the game.
```

```
   22
\ CAPTURE - GAME                                      BTN 04-14-1988

: GAME   BEGIN  TELL PLAY  50000 0 DO LOOP
          0 24 AT  ." Play again? (Y/N) "
          Y/N  ANOTHER @  1 =  UNTIL  CLS
          BYE  ;
```

```
   46
\ CAPTURE - GAME                                      BTN 04-18-1988

: GAME           Play the game of Capture.
```

```
   23
\ CAPTURE - Build System                              BTN 04-16-1988

ONLY FORTH ALSO DOS ALSO          \ search DOS and Forth

: CAPTURE    EMPTY-BUFFERS        \ dummy program name
  " CAPTURE.BLK" FCB1 (!FCB)      \ parse filename to fcb
  FCB1 !FILES OPEN-FILE           \ open the file to list
  GAME             ;

ONLY FORTH ALSO                   \ power up search order
' CAPTURE IS BOOT                 \ make demo run automatically

SAVE-SYSTEM CAPTURE.COM           \ create capture.com file
```

```
   47
\ CAPTURE - Build System                              BTN 04-14-1988

                                  This screen is used
                                  to build a .com file
                                  of the program.  This
                                  eliminates the need to
                                  compile ( LOAD ) the
                                  application each time
                                  it is needed.
```

.CAME-FROM

FRANS VAN DUINEN - ETOBICOKE, ONTARIO, CANADA

Years ago, when structured programming was still relatively new, there was an article about goto-less programming using the "came from" construct. Since it appeared in the April issue (*Datamation*, I think), it made amusing reading and that was it. It is somewhat ironic, then, to be implementing a "came from" in what may be the most structured of all languages, Forth.

"Most of the CFA's were zero...a system reboot every time."

I've been doing some neat stuff with table-driven applications. For one of these, the basic data structure is a list of addresses of other data structures, which in turn point to other lists of yet other addresses; there are four levels of structures and address lists in total.

The implementation uses something like user variables, with a separate base pointer for each of the four levels. The addresses in the list are the CFAs (code field addresses) of words to initialize the base pointer.

The problem was that, during testing, the program kept trying to EXECUTE variables for which the base pointer had not been properly initialized. Most of the executed CFAs were zero. That meant a system reboot every time.

Hence the following test version of EXECUTE to check that the CFA to be executed is at least reasonable (i.e., within the application). It uses EXEC? to check that the address is in the range from ' EMPTY (or, as used here, from ' INTERPRET 2-) to HERE. If not, ABORT (see Figure One).

```
VARIABLE (EXEC-FENCE)
' interpret 2- (EXEC-FENCE) !

: EXEC?
  (EXEC-FENCE) @ HERE  >R OVER U> SWAP R> U> OR NOT ;

: EXECUTE  (S cfa -- )
  DUP EXEC? NOT
  IF TRACE-BACK  .STACK TRUE ABORT" EXEC error " THEN
  EXECUTE  ;
```

Figure One. Bulletproofing EXECUTE.

The next step was to show the return stack and the data stack just prior to ABORT by using .TRACE-BACK and .STACK. The word .SR shows the return stack, and is a simple transliteration of .S which, in F83, shows the data stack (see Figure Two).

```
: .CAME-FROM
  DUP EXEC? SWAP 2- @ SWAP OVER
  EXEC? AND IF ." =" >NAME .ID
  ELSE DROP THEN  ;

: .SR  R>               \Hide own return address
  RP0 @ RP@ - 2/        \# of entries on return stack
  ?DUP IF
    0< IF ." Underflow "
    ELSE  RP@ RP0 @ 2-          \RP0 byte after return stack
      DO I @ DUP 5 U.R .CAME-FROM SPACE
      KEY? ?LEAVE  -2 +LOOP
    THEN
  ELSE  ." Empty"  THEN >R  ;

: TRACE-BACK  ." R stack:" .SR CR  ;

: .STACK  ." Stack:"  .S CR  ;
```

Figure Two. Where did we come from?

The return stack, of course, contains

(Continued on page 32.)

Forth-83

TIME-KEEPING ROUTINE

PETER VERHOEFF - GLENDALE, CALIFORNIA

If, like me, you work odd hours and would like to somehow keep track of how much time you spend at your computer each week, you may find this program useful. It is written in F83 version 2.1 for the IBM PC and compatibles.

This program records the length of the current session, the total time for the day, the total for the current week (or other period of your choice), and remembers the total for the previous period. It also records the date and time in ASCII format when you log in or out, which can then be printed so that you have a record of exactly when you logged in and out.

How to Use It

Two files are used: TIMELOG.COM, the compiled form of the program, and TIME.LOG, the file containing the logging data. I made TIME.LOG three blocks long, which holds almost 50 pairs of login and logout times.

To register a login time, you type `TIMELOG IN` from the DOS command line. Likewise, `TIMELOG OUT` will record the time you log out. Actually, just the letter `I` or `O` after the `TIMELOG` command will do the trick.

When you log out, it subtracts the time you logged in to compute the session time, and adds this to the daily total and the total for the period. To start from scratch, you would type `TIMELOG R`. This simulates a logout followed by a login, moves the current period total to the previous period, and then clears the current period total. The session total is always cleared by a login, and the daily total is cleared by a login if the day differs from the previous day of login.

My work week ends at two p.m. on Thursdays, and I have therefore included another command: `TIMELOG N`. When I issue this command, the new week is started at two p.m. sharp (it gets the two p.m. from memory, not the clock.) Other than that, it works the same as the `R` command and could be used instead of it. The `R` command, however, is useful if you have been away for some days, and weren't there on Thursday to add the total for the week; you'd start the new week right then. Of course, it will work just as well on periods longer than a week, but you should increase the TIME.LOG file size accordingly.

If, during a session, you wish to know how much time you've put in, you can do so by using the command `TIMELOG Q`. This will display the data of any of the above commands, but won't make any permanent changes to the logging file.

"These routines store the date and time into a log file that can be printed."

How It Works

My intention in writing this program was first to provide a useful application and, second, to provide clean and elegant code that may be of interest to readers. Being a firm believer in keeping things simple, I adopted the approach of deferring complexities at the higher levels of the code. It also seemed logical to list the program in reverse order, so that in explaining the program, the higher-level concepts are presented first.

The top-level word on screen 17 consists of just three parts: a beginning, a middle, and an end. That's about as simple as it can get. The code at the bottom of the screen makes it possible to execute the program automatically from the DOS command line.

Screen 16 is where the different options get selected. I considered creating a case command for the occasion but decided against it, because it would only be used once and the code is pretty easy to follow anyway.

`INIT` on screen 15, again consisting of three words, gets your choice from the DOS command line, reads the log file, and gets the current date and time. The other two definitions on this screen aren't quite as tersely defined, but nonetheless are pretty straightforward. One word worth noting is `START`, an F83 word which opens the DOS "default" file (normally obtained from the command line, but not in this case).

The code for `NOW`, on screen 14, is almost COBOL-like in its definition, where you would say something like:

```
MOVE DATE TO PRESENT-DATE
MOVE TIME TO PRESENT-TIME
```

In Forth, of course, we use reverse notation, so the `MOVE` goes at the end and gets renamed to `PUT` because we already have a `MOVE` word in Forth.

`NOW` hides quite a lot of data: `DATE@` and `TIME@` each put four bytes on the stack, which are stored into the log file by `PUT`, using offsets defined by `PRESENT`, `DATE`, and `TIME`. I find the idea of using words to define offsets interesting and similar to adjectives in human language, in that they modify the object.

Also on screen 14, NEW.WEEK sets the present time to 14:00:00:00 hours (since my new week starts and ends at two p.m.) and then does a RESET, which does a simulated logout and login, moves the current week to last week, and zeroes the new week.

LOG.IN, on screen 13, checks if today's date differs from the previous login date and, if so, clears the daily total. It also resets the session time and saves the login date and time. On the same screen, LOG.OUT and INQUIRE are almost identical, except that LOG.OUT saves the changes that were made, and INQUIRE doesn't.

STRETCH, on screen 11, inserts 32 bytes at the start of block zero of TIME.LOG and moves everything else up. The last 32 bytes of the last block are saved just before the insert, since that is where the binary totals are being kept, and SAVE.END on screen ten is the word that puts those values back. This permits us to use the log file like a stack, with the most recent entry first. It is also independent of the number of blocks in the file.

Screens eight and seven deal with string handling. The purpose of these routines is to store the ASCII date and time into the log file in a format that can be printed out later, to provide something like an audit trail. The routines are commented pretty well. The only unusual definition is of $+C. SP@ gives the address of the character on the stack. Next, a one is pushed onto the stack, thus defining a one-character string which can then be processed by PLACE+ to be appended to the already existing string in INBUF.

Screens six and five contain logic to add with carry, and to subtract with borrow. The time calculations could, of course, be done by converting everything to hundredths of a second, but I consider this a more interesting way of doing it.

The routines that extract the time and date are on screen four. The time and date are converted into four separate bytes each, for uniformity and to simplify processing.

Screen three contains some primitive words and screen two contains the constants and buffers used.

Final Note

I have used this program during the last few months and find it useful. One feature that could be added is a re-totalling option. Occasionally I forget to log in or out, which throws off the totals. The log file can be edited, but I didn't get around to writing a re-totalling routine yet. Perhaps you can come up with a neat way to do that?

```
TIMELOG.BLK  Screen 17
      \  LOG.TIME

     : LOG.TIME   (S -- )             \ Top level time keeping word.
        INIT                          \ Open log file, get input char.
        CHOICE                        \ Decide what to do and do it.
        FINAL ;                       \ Wrap up the actions.

     ' LOG.TIME IS BOOT               \ for automatic execution
```

```
TIMELOG.BLK  Screen 16
      \  CHOICE

     : CHOICE    (S char -- )         \ Input char determines what next
        DUP ASCII I =
        IF DROP " IN:      " LOG.IN   \ On login check daily total.
        ELSE DUP ASCII O =
           IF DROP " OUT:     " LOG.OUT \ On logout update total also.
           ELSE DUP ASCII N =
              IF DROP NEW.WEEK        \ Close old week, start new one.
              ELSE  ASCII R =
                 IF RESET             \ Start new week now.
                 ELSE INQUIRE         \ Just check current status.
                    ." Choices: In, Out, New, Query, Reset"
        THEN THEN THEN THEN ;
```

```
TIMELOG.BLK  Screen 15
      \  INIT  GET.FILE  FINAL

     : FINAL  (S -- )                 \ Display data and exit.
        CR 0 BLOCK $LEN 2* TYPE       \ Display last 2 entries.
        .TOTALS  FLUSH  0 0 BDOS ;    \ Write data and exit.

     : GET.FILE  (S -- )              \ Open time keeping file.
        [ DOS ]   DOS-FCB  CLR-FCB    \ Clear file control block.
        " TIME    LOG" DOS-FCB 1+     \ Get time keeping file name.
        SWAP  CMOVE  START  ;         \ Put file name in fcb & read it.

     : INIT   (S -- char )            \ Initialize and get input char.
        DOS.CHAR                      \ Get dos command line character.
        GET.FILE                      \ Open the time keeping file.
        NOW  ;                        \ Get the date and time.
```

(Verhoeff screens, cont.)

```
TIMELOG.BLK  Screen 14
       \  NOW  NEW.WEEK  RESET

       : RESET  (S -- )               \ Use this if starting afresh.
         " OLD:    " LOG.OUT          \ Close out last week.
         " NEW:    " LOG.IN           \ Start a new week.
         WEEK TIME LASTWK TIME XFER   \ This week becomes last week.
         ZERO  WEEK TIME  PUT ;       \ New week's total is zero.

       : NEW.WEEK  (S -- )            \ Do only after totals displayed.
         14 0 0 0  PRESENT TIME  PUT \ My new week starts at 2 pm.
         RESET  ;                     \ Go and fix the totals.

       : NOW  (S -- )                 \ Get and save the date and time.
         DATE@  PRESENT DATE  PUT     \ (Only used at entry time.)
         TIME@  PRESENT TIME  PUT ;



TIMELOG.BLK  Screen 13
       \  LOG.IN  LOG.OUT  INQUIRE

       : INQUIRE (S -- )              \ Session length = now - in time.
         PRESENT TIME  LOGIN TIME  SUB   SESSION TIME  PUT
         SESSION TIME  DAILY TIME  ADD   DAILY   TIME  PUT
         SESSION TIME  WEEK  TIME  ADD   WEEK    TIME  PUT  ;

       : LOG.OUT  (S adr cnt -- )     \ Log out and add up totals.
         INQUIRE  SAVE.TIMES ;        \ Get elapsed time and log it.

       : LOG.IN   (S adr cnt -- )     \ Log in date & time = now.
         PRESENT DATE DAY  LOGIN DATE DAY  DIFF?
         IF NEW.DAY THEN              \ New day if not last login day.
         ZERO  SESSION TIME  PUT      \ Start new session.
         PRESENT DATE  LOGIN DATE  XFER  \ Update the time log.
         PRESENT TIME  LOGIN TIME  XFER  SAVE.TIMES  ;



TIMELOG.BLK  Screen 12
       \  NEW.DAY  ZERO  DIFF?  XFER  SAVE.TIMES

       : SAVE.TIMES  (S adr cnt -- )  \ Save the log and update file.
         STRETCH  SAVE.END            \ Make room in file, save totals.
         MAKE$  PUT$  ;               \ Put ascii log time in file.

       : XFER (S oa1 oa2 ob1 ob2 -- ) \ Transfer time from a to b.
         >R >R GET R> R> PUT  ;

       : DIFF? (S oa1 oa2 oa3 ob1 ob2 ob3 -- t|f ) \ Compare 2 units.
         UNIT@ >R UNIT@ R> = NOT ;    \ True if different.

       : ZERO  (S -- 0 0 0 0 )  0 0 0 0 ; \ Four zeros.

       : NEW.DAY (S -- )              \ Start a new day.
         ZERO DAILY TIME PUT ;
```

(Screens continued on page 34.)

(Continued from page 29.)

the return address(es) in the calling word(s) and how we got to the point in the program where it failed. Doing DUMPs for each address on that stack to look for the name of the calling word was not, however, the way to go.

.CAME-FROM takes care of that (Figure Two). We know that the address on the return stack points in the calling definition following the two bytes whose content points to the CFA of the word currently executing (nested). Of course, there are occasionally values on the return stack that are not return addresses (e.g., after >R, loop control, etc.). There are also words like ?BRANCH and LITERAL that adjust the return address to skip past some in-line parameter. But by and large, if the address on the stack and the address it points to are both in a reasonable range, the latter probably points to a CFA.

The word .CAME-FROM does a reasonableness test (?EXEC) on the two addresses it uses and, if they both look good, uses >NAME .ID to go from CFA to NFA (name field address) and display the name.

Note that .CAME-FROM outputs something like ... 2A64=INTERPRET. That does not mean that INTERPRET is at 2A64. It does mean that the return stack contains 2A64, which corresponds to INTERPRET being the word that called us (at 2A62 we found the address of the CFA of INTERPRET).

Advertisers Index

THE BEST OF GENIE

GARY SMITH - LITTLE ROCK, ARKANSAS

Among the many things to which Forth is suited, real-time control has to rank as its strongest suit. Included in this ever-expanding category is the control of robots. Since the subject of robotics is near and dear to many Forth enthusiasts, it would be fair to expect discussion of such on the GEnie Forth RoundTable. In fact, Category 6, Topic 9 is devoted to robotics; and in this issue we will sample the knowledge that is there for the asking.

Topic 9
Mon Sep 07, 1987 ATFURMAN
[Alan F.]
Sub: Autonomous mobile & hobby robotics. This topic also includes legged locomotion.

Category 6, Topic 9, Message 2
Mon Sep 07, 1987 ATFURMAN
[Alan F.]

Radio-Electronics magazine has been publishing a series of articles on building a mobile robot programmed in Forth (actually a robot-control wordset called RCL for "Robot Control Language") since December 1986. A kit of mechanical parts is offered by mail order. The robot has a one-degree-of-freedom "arm" (gripper on a vertical positioning slide). It has two powered wheels and a control board with an Intel 80186. The board is one of several SBCs sold bundled with Forth, and is made by Vesta Technology, Wheatridge, Colorado (which just happens to be run by the author, Steven E. Sarns). Thanks to George Shaw for alerting me to this one.

I have not been following the series, so I do not know how sophisticated the software has gotten. This does seem like a great opportunity to blow the field away with some AI extensions to the Forth system. In fact, one of the niftiest AI hacks in Forth was created precisely for an autonomous mobile robot (at Oak Ridge National Laboratory; see "The Internals of FORPS: a FORth-based Production System" by Christopher Matheus, *Journal of Forth Application and Research*, Vol. IV, No. 1, pp. 7–27 (1986). The inference engine and rule compiler take about *one page* of source and originally ran on a Z80. Now imagine running this on a Forth engine.

"A good feedback servo motor controller is a real thing of beauty..."

Category 6, Topic 9, Message 3
Tue Sep 08, 1987 S.W.SQUIRES [scott]

Versions of FORPS are available in the file directory for a few different computers. Search for FORPS.

Category 6, Topic 9, Message 4
Tue Sep 08, 1987 S.W.SQUIRES [scott]

I may be involved with a mobile cart for a future project. Since the wheels may be rubber, there will be some slippage. Does anyone know of good single-axis measurement-sensing system? Objective: the cart will be portable and will be in different environments with a minimal amount of setup time. Distance traveled will be from a few feet to 50 feet. Position resolution must be 1/100 of an inch or better. Update at a speed of 60 to 100 times per second. The technology must be practical with little maintenance. Possible ideas we've started to examine:

Ultrasonics. Disadvantage: resolution and distance limited.

Laser. Disadvantage: complexity.

Magnetic field. Disadvantage: not practical, given amount of metal and other factors.

Visible focus (similar to Autofocus cameras). Disadvantage: complexity and limited resolution.

Grid on ground. Disadvantage: not practical in environment.

Tape on ground. Bar-code-style markings would be printed on the tape. This looks the most promising so far.

Although this is for a single axis, I'd be curious to know about three-dimensional measurements given the same criteria. —Scott

Category 6, Topic 9, Message 5
Tue Sep 08, 1987 ATFURMAN [Alan F.]

David Jaffe of the Palo Alto (California) Veterans Administration Hospital rehabilitation research group (and soon to be on GEnie) is connected with people doing mobile robot research at Stanford University. In particular, Larry Leifer of the Mechanical Engineering faculty.

Category 6, Topic 9, Message 6
Tue Sep 08, 1987 ATFURMAN [Alan F.]

Scott: Is this robotic cart connected with ILM? What is it for?

Category 6, Topic 9, Message 7
Wed Sep 09, 1987 S.W.SQUIRES [scott]

(Verhoeff screens, cont.)

```
TIMELOG.BLK  Screen 11
      \  STRETCH  $INS  OUT>IN

      : OUT>IN (S -- )              \ Move outbuf data to inbuf.
        OUTBUF COUNT INBUF PLACE  ;

      : $INS   (S bl.adr n -- )     \ Insert n chars at start of blk.
        2DUP - B/BUF + OVER OUTBUF PLACE \ Save end of block.
        2DUP 2DUP >R + B/BUF R> - CMOVE> \ Move everything up.
        INBUF 1+ -ROT CMOVE ;            \ Put data from in-buffer.

      : STRETCH  (S -- )            \ Insert 32 bytes into file.
        $LEN  CAPACITY 0            \ Do from block 0 to eof:
        DO
           I BLOCK  OVER $INS       \ Insert into each block.
           UPDATE   OUT>IN          \ Save change, outbuf to inbuf.
        LOOP DROP ;



TIMELOG.BLK  Screen 10
      \

      : PUT$  (S -- )               \ Save ascii time string in file.
        INBUF COUNT  0 BLOCK  SWAP CMOVE  UPDATE ;

      : SAVE.END  (S -- )           \ Save totals at end of file.
        INBUF COUNT  CAPACITY 1-    \ After stretch, totals in inbuf.
        BLOCK B/BUF + OVER -        \ Save at end of last block.
        SWAP CMOVE  UPDATE  ;



TIMELOG.BLK  Screen 9
      \  .TOTALS  DISPLAY  MAKE$

      : MAKE$  (S adr cnt -- )      \ Text, date, and time in ascii.
        INBUF PLACE                 \ Save identifier in inbuf.
        PRESENT DATE  GET  $+DATE   \ Append the date.
        PRESENT TIME  GET  $+TIME ; \ Append the time.

      : DISPLAY (S adr cnt o1 o2 --) \ Display message and time.
        2SWAP  INBUF PLACE GET       \ First store the message.
        $+TIME INBUF COUNT TYPE ;    \ Then the time and display.

      : .TOTALS (S -- )  CR          \ Print totals.
        " Total for session " SESSION TIME DISPLAY
        " Total for  to-day " DAILY   TIME DISPLAY
        " Total this period " WEEK    TIME DISPLAY
        " Total last period " LASTWK  TIME DISPLAY ;



TIMELOG.BLK  Screen 8
      \  $+TIME  $+DATE  $+#  $+C

      : $+C  (S char -- )           \ Append character to string.
        SP@ 1 INBUF PLACE+ DROP ;   \ Treat stack as 1-char string.

      : $+#  (S # -- )              \ Append number to string.
        0 <# # # #> INBUF PLACE+ ;

      : $+DATE  (S cc yy mm dd -- ) \ Append date to INBUF.
        INVERT $+# $+# ASCII . TUCK \ Append year. Period delimits.
        $+C $+#  $+C $+#  BL $+C ;  \ Append .mm.dd and a space.

      : $+TIME  (S hh mm ss .ss -- ) \ Append time to INBUF.
        INVERT $+# ASCII : TUCK      \ Append hh:mm:ss.ss <cr> <lf>.
        $+C $+#  $+C $+#  ASCII . $+C $+#  13 $+C  10 $+C ;
```

(Screens continued on page 35.)

This would be a live-action dolly system with the same requirements as a normal dolly but be repeatable. This is just in an idea stage, so it might not become a reality. —Scott

Category 6, Topic 9, Message 8
Thu Sep 10, 1987 ATFURMAN
[Alan F.]

All right. You guys want 0.25 mm. resolution over a 1.5–15 meter range of movement. I guess you are already aware of the avalanche of papers in the robotics literature on two subjects: navigation for mobile robots (obviously) and 3D sensors (for mobile robots and also for workpiece inspection and robotic bin picking). SPIE, SME, and IEEE run conferences with voluminous proceedings annually that address these topics. Here are a few thoughts:

Putting a target on the dolly and determining its position by triangulation requires a resolution of four seconds of arc. Theodolites are made that resolve 0.01 seconds, so it is potentially feasible.

A company called Digital Optronics is gearing up to commercialize very-high-resolution laser range finders. Rather than using time of flight (which performs poorly with attainable time resolution), these gadgets apparently chirp the (long-pulse) beam and heterodyne it with the return. Distance variations translate into *frequency* variations in the beat note. Clever, what? Of course, using it would still entail gimbal mounts and angular tracking of the dolly as it moves.

Coded tape is a contender, given the assumption that dolly motion is planned in advance, rather than arbitrary. More in our next episode...

Category 6, Topic 9, Message 9
Thu Sep 10, 1987 ATFURMAN
[Alan F.]

Coded tape for repeat path sensing, continued from previous posting. Consider, if you will, the pattern [in Figure One] printed on, say, mylar tape.

A CCD camera aboard the dolly looks directly downward at this tape, which is stuck onto the floor. A simple image-processing algorithm locates a line crossing in the pattern, and compares its position in the image to the position seen during the lead-through programming run. Ambiguities as to which crossmark it is are resolved by taking a cut (in software) through one of the bar codes (which label the scale every 1/10 meter).

Using one of the 512 x 512 sensors available now, and with optics imaging at 0.25 mm. per pixel, the camera will cover a field of 12.8 x 12.8 cm. For more coverage, sub-pixel resolution can be used. One approach to the latter is to use a fancier target pattern, as in Figure Two, for example, in which at least two lines not parallel to the grid axes of the sensor are guaranteed. The software can then fit line equations to the diagonal pixel patterns (which smooths out the spatial sampling errors) and calculate their intersection. The software will also have to be smart enough to deal with wrinkles and overlapping ends of tape strips.

Cheers, Alan

Category 6, Topic 9, Message 10
Fri Sep 11, 1987 S.W.SQUIRES [scott]

Thanks for all the feedback Alan. Sounds like you're quite involved with these areas.

I looked at some of the optical and laser techniques when I was at the SPIE show this year. Would rather keep it a bit simpler. Your thoughts on tape are good. We were looking at a bit lower tech. The tape would have two or more parallel patterns, each being read with a separate simple photodetector. This would allow some fault tolerance. The tape would probably be of plastic, mounted to a channel on the track to avoid being stepped on. Mounting the tape on the side or upside down might also be done. Relative marks would probably be fine but, if not, we might use something similar to the SMPTE code. A single 'channel' of data should suffice if done correctly.
—Scott

Category 6, Topic 9, Message 11
Sun Sep 20, 1987 ATFURMAN [Alan F.]

Since getting on GEnie, I have learned of the existence of the Macbot autonomous mobile robot project: a loosely defined, public-domain, hacker-community effort that seems to be drifting toward adopting Forth as the main programming language. References: several files in the Forth Applications DL, and postings under Category 12 in the "Mac developers" RoundTable.

The Macbot group figures that spinoffs alone (usable designs in servo control, AI, etc.) would pay for the effort, but practical

(Verhoeff screens, cont.)

```
TIMELOG.BLK  Screen 7
       \  INVERT  PLACE+

       : PLACE+  (S from cnt to -- )  \ Like PLACE, but adds string.
          2DUP COUNT TUCK + -ROT + ROT C!  \ Update count.
          SWAP CMOVE ;                   \ Then move string.
       \ Example: if STRING contains 'Hello ',
       \ then " Joe" STRING PLACE+ will result in
       \ 'Hello Joe' at STRING (1st byte = count.)

       : INVERT  (S a b c d -- d c b a ) \ Invert 4 items on stack.
          SWAP  2SWAP  SWAP  ;
```

```
TIMELOG.BLK  Screen 6
       \  TIME+  +C  ADD

       : +C  (S x y w -- 0 x+y | 1 x+y-w ) \ Add with carry.
          -ROT  + 2DUP >               \ Add a to b, compare with w.
          IF   NIP 0                   \ If sum < w means no carry.
          ELSE SWAP - 1                \ Else subtract w, carry = 1.
          THEN SWAP ;                  \ Keep sum on top.

       : TIME+  (S hi mi si .si ho mo so .so -- h m s .s ) \ Add times.
          4 ROLL 100 +C  >R +          \ Save .so + .si.
          3 ROLL  60 +C  >R +          \ Save  so +  si.
            ROT   60 +C  >R +          \ Save  mo +  mi.
            + R> R> R> ;               \ Sum in hrs min sec secs/100.

       : ADD  (S oa1 oa2 ob1 ob2 -- h m s .s ) \ Add times by offsets.
          >R >R GET R> R> GET TIME+  ;
```

```
TIMELOG.BLK  Screen 5
       \  TIME-   -B  SUB

       : -B  (S x y w -- 0 x-y | -1 x-y+w ) \ Subtract with borrow.
          -ROT  -  DUP 0<              \ Subtract y from x.
          IF + -1                      \ If negative, borrow w.
          ELSE NIP 0                   \ Else get rid of w.
          THEN SWAP ;                  \ Keep difference on top.

       : TIME- (S hi mi si .si ho mo so .so -- h m s .s ) \ Out - in.
          4 ROLL 100 -B  >R +          \ Save .so - .si.
          3 ROLL  60 -B  >R +          \ Save  so -  si.
            ROT   60 -B  >R +          \ Save  mo -  mi.
            SWAP  24 -B  NIP R> R> R> ; \ Diff in hrs min sec secs/100.

       : SUB  (S oa1 oa2 ob1 ob2 -- h m s .s ) \ Subtract a - b.
          2SWAP >R >R GET R> R> GET TIME- ;
```

(Screens continued on page 36.)

(Verhoeff screens, cont.)

```
TIMELOG.BLK  Screen 4
      \  TIME@  (TIME)  DATE@  (DATE)

      CODE (DATE) (S -- yyyy mmdd )  \ Get the date from the system.
         42 # AH MOV  33 INT
         CX PUSH  DX PUSH  NEXT  END-CODE

      : DATE@  (S -- cc yy mm dd )   \ Get date in byte format.
         (DATE)  SWAP 100 /MOD SWAP ROT CHOP ;

      CODE (TIME)  (S -- hhmm ss.ss ) \ Get the time from the system.
         44 # AH MOV  33 INT
         CX PUSH  DX PUSH  NEXT  END-CODE

      : TIME@  (S -- hh mm ss .ss )  \ Get the time in byte format.
         (TIME) SWAP  CHOP  ROT  CHOP ;
```

```
TIMELOG.BLK  Screen 3
      \  CHOP  UNIT@  GET  PUT  'INFO

      : 'INFO  (S -- addr )          \ This is where it is stored.
         CAPACITY 1- BLOCK B/BUF + $LEN - ;

      : PUT  (S a b c d o1 o2 -- )   \ Store 4 bytes at 'INFO+O1+O2.
         + 'INFO + FULL + FULL 0 DO 1- TUCK C! LOOP DROP ;

      : GET  (S o1 o2 -- a b c d )   \ Get 4 bytes from 'INFO+O1+O2.
         + 'INFO + FULL 0 DO COUNT SWAP LOOP DROP ;

      : UNIT@  (S o1 o2 o3 -- a )    \ Get 1 byte from 'INFO+O1+O2+O3.
         + + 'INFO + C@ ;

      : CHOP  (S xxyy -- xx yy )     \ Chop word into 2 bytes.
         256 /MOD SWAP ;
```

```
TIMELOG.BLK  Screen 2
      \  Constants and buffers.

        0 CONSTANT  DATE                8 CONSTANT  TIME
        0 CONSTANT  PRESENT             4 CONSTANT  LOGIN
        8 CONSTANT  SESSION            12 CONSTANT  DAILY
       16 CONSTANT  WEEK               20 CONSTANT  LASTWK

        0 CONSTANT  CENTURY             1 CONSTANT  YEAR
        2 CONSTANT  MO                  3 CONSTANT  DAY
        0 CONSTANT  HR                  1 CONSTANT  MINS
        2 CONSTANT  SEC                 3 CONSTANT  .SS

        1 CONSTANT  UNIT                4 CONSTANT  FULL
       32 CONSTANT  $LEN
          CREATE INBUF $LEN 1+ ALLOT    CREATE OUTBUF $LEN 1+ ALLOT
      : DOS.CHAR  130 C@  UPC  ;      \ Get input character.
```

(Screens continued on page 37.)

applications like aids to the handicapped have been mentioned. The only fixed quantity seems to be the Macintosh as central controller. Actually, the best controller choice would be the 32-bit Forth virtual machine, whether implemented on a Mac, Atari ST, Amiga, or 386 PC bus system (the last two choices would make interfacing easier).

Macbot activity on GEnie stalled this summer; I do not know what is going on with the project itself (it appears to live mainly on Compuserve). The leader of the project, B.W. Lightsey, is on GEnie; B.W.LIGHTSEY is his address.

Category 6, Topic 9, Message 12
Sat Nov 14, 1987 H.SIMMONS

Lacking practical experience, this suggestion may not have merit, but it would seem that the use of a fifth wheel would provide sufficient accuracy to allow for only occasional calibration by moving the dolly to a known location. If the dolly is to have two-dimensional travel, a larger-than-handheld "mouse" with larger ball should do the job.

For calibration, perhaps laser diodes attached to the ceiling at strategic positions, which could fire in response to an ultrasonic signal from the dolly? Is there any possibility of placing ultrasonic targets or "calibration tape" on the ceiling to get regular position information? —Horace

Category 6, Topic 9, Message 13
Mon Nov 16, 1987 S.W.SQUIRES [scott]

Good suggestions, but the travelling wheel would probably have some accuracy problems over long runs. The ceiling, for most applications, might be 40+ feet up and differ from a regular ceiling; or it may be outside in some projects, with no ceiling. Not much is happening with this currently, so I'm on to other projects. —Scott

Category 6, Topic 9, Message 14
Sun Oct 02, 1988 S.W.SQUIRES [scott]

Those interested in Robotics and AI may want to check the October issue of *OMNI* magazine. There is a article on the insect robots designed by Rodney Brooks at MIT's Artificial Intelligence Laboratory. The potential applications and approaches are discussed. The article includes step-by-step instructions on how to modify a cheap toy car from Radio Shack and add electronics to simulate some of the responses of an insect ($50–75 total). All the logic is actually photocells, Op Amps and TTL logic, but a person should be able to replace that logic with a small Forth board that does that and much more. As I recall, *Scientific American* had a "Computer Recreations" article a couple of years ago describing similar photocell-controlled vehicles. —Scott

Category 6, Topic 9, Message 15
Sat Dec 03, 1988 R.SCHEMMEL1 [JEPEDO]

Gentlemen, allow me to be of assistance. Robotics is my main objective and I would be glad to participate in a group project. I can provide technical reference information in electronics to almost any degree of detail, as far as circuitry goes. However, as I am sure you are aware, the sheer magnitude of new technology is staggering and, although I have a nice assortment of very recent engineering books on robotics-related subjects, nevertheless it is relatively equivalent to having a few fish out of the ocean: compared to what you don't have, you have nothing, but it's still enough to feed you...

Also, my forté is prototyping circuitry and fabrication of an electronic nature, to wit, building circuits, equipment, etc. including motor control. Feedback servos are, of course, the only way to get real precision but are incredibly involved, both design-wise and in prototyping and testing. A good feedback servo motor controller is a real thing of beauty: it flies through the air with the greatest of ease and stops close enough to a dime standing on its edge to knock it over with the air pressure and still not touch it. The precision standard four years ago was 1/1000 of an inch, but these days they have stuff that can thread a needle (literally) with plenty of clearance—if you have enough money. Anyway, if you need something prototyped and have the design but need an engineering technician to build it, I might be able to help you. I am hoping I'll eventually learn enough about Forth to program the hardware I build, but at the moment I couldn't program my way out of a paper bag.

Personally, I'll take a Forth engine over anything else for a main CPU or control processor. I just wish I could afford one!

(Verhoeff screens, cont.)

```
TIMELOG.BLK  Screen 0
       \  Time keeping program  TIMELOG.BLK

       Copyright (c) 1988 by Peter Verhoeff
       308 N. Louise Ave. #14
       Glendale CA 91206

       This program is freely available for private use.
       Commercial use of this program or any part thereof requires
       written permission from the author.

       This program has been written in F83 Forth, version 2.1.0.
```

(Continued from page 4.)

Other Forth-specific BBS's

- Laboratory Microsystems, Inc.
  213-306-3530
  SysOp: Ron Braithwaite

This list was accurate as of March 1989. If you know another on-line Forth resource, please let me know so it can be included in this list. I can be reached in the following ways:

Gary Smith
P. O. Drawer 7680
Little Rock, Arkansas 72217
Telephone: 501-227-7817
Fax: 501-228-0271
Telex: 6501165247 (store and forward)
GEnie (co-SysOp, Forth RoundTable): GARY-S
BIX (Bytenet): GARYS
Delphi: GARY_S
MCIMAIL: 116-5247
CompuServe: 71066,707
Wetware Diver. (Fairwitness, Forth Conference): gars
Usenet domain.: gars@well.UUCP *or* gars@wet.UUCP
Internet: well!gars@lll-winken.arpa
WELL: gars

**ForthNet is a virtual Forth network that links designated message bases in an attempt to provide greater information distribution to the users served. It is provided courtesy of the SysOps of its various links.*

Category 6, Topic 9 Message 16
Sun Dec 04, 1988 R.SCHEMMEL1 [JEPEDO]

Scott, for your information the RE-ROBOT uses an 80188, not 80186 as you mentioned. Also, for those interested, the RR-BBS phone number is 516-293-2283. It was busy every time I called, but they have a section for RE- ROBOTEERS, so to speak.

Also, on the subject of rubber wheel slippage I would suggest you forget that word "slippage" because all you *really* care about is not how much you've slipped, but where you are when all the slipping is over. That is, concentrate on getting your bearings using something like the Polaroid Infrared range sensor for course measurements and a doppler-type ultrasonic sensor for a complementary input. You'll need something photoactive for fine distance measurements and I would recommend a high-powered infrared LED mounted on a one-axis mount or a disk such that it can change the angle at which it shines on the path or the wall. Have a strip of infrared optical transistors running along the base strip all the way around so the transmitter scans back and forth, sending a pulsed beam at a preset frequency which the transistors receive. Multiplex the transistor detectors for a signal and test the signal found for the correct frequency to eliminate all light not sent by the transmitter.

Admittedly this is a crude method, but the key to making it work is using linear transistors and sensing amplitude of return signal rather than switching type in an on/off setup. By varying the current to your scanning transmitter LED and sensing linearly varying light pulses returning, you have the ability to make either "short range" or "long range" sensor scans. By using the amplitude of the return light signal to vary the frequency of a voltage-to-frequency converter IC (there are many available), you can measure the frequency of the signal you have generated and use that when you wish to know the distance.

The cart sensor navigation system is calibrated by driving it in a learning mode through an obstacle course and recording all sensor readings. The measurements are used to establish equivalent parameters such that a data value X equals ten feet, or six feet, or one foot etc.The readings, of course, are never the same for different areas so, given a large memory capacity for read-*only* data (CD ROM would be ideal, but a large hard disk will do), you can record all the readings for points along the path and store them once as data—this is a map which has no value to anyone except the robot that generated it, to which these readings represent real places it has been to once. Therefore, it can do a string search or approximation comparison of real-time readings with its stored map data and determine that it is about three feet from the drinking fountain in front of the elevator door on the second floor near the east wing at about 4:00 p.m., when the sun coming through the window is at its lowest. As you can see, place is only part of the problem; the time must be recorded when the map is generated. That is, the data header for the sensor readings must always contain a date-stamp or the readings will lose much of their value. As a matter of general practice, *all sensor readings of any nature* should contain a date stamp, as this information will be invaluable later.

"Jepedo is the name and robots are my game."

```
 _____________________________________________________________
/                                                             /
\   |         |         |         |         |         |       \
/---+---------+---------+---------+---------+---------+-------/
\   |         |         |         |         |         |       \
/                                                             /
\        || | ||||                                            \
/                                                             /
\_____________________________________________________________\

    |<-1 cm.->|
```

Figure One. Ruled tape with bar code labels at ten-centimeter increments.

```
   \ /         \ /
---x---------x-------
   / \         / \
```

Figure Two. Targets used to achieve sub-pixel resolution require calculation.

THE GREENING OF FORTH

JACK WOEHR - 'JAX' ON GEnie

Many proverbs of our civilization indicate that he who wishes to lead must discover in which direction the people are heading and then place himself in front of them.

The Forth Interest Group has been a leader of the steady and inspiring progress of the Forth programming environment for well over a decade. Recently, however, the question arises, "Is anyone still following?"

Forth is more popular than ever. The surest gauge of the health and well-being of Forth is to be had in the number of annual annoucements of its impending death. Last year was perhaps a banner year for Forth, its demise being proclaimed in forums where its name had not previously been heard, such as John Dvorak's writings.

Forth in 1988 acquired a powerful and influential patron in Harris Semiconductor. No less than Dr. C.H. Ting has testified that, "I used to think I knew all the preachers of Forth," but after attending a Harris RTX2000 seminar, he owned that he had heard the gospel preached eloquently by well-informed individuals previously unknown to the small and cozy Forth community.

Forth continues to sweep the field of microprocessor-based embedded systems. FORTH, Inc. announced in 1988 several innovative extensions of their line of embedded-system-targeted polyFORTHs.

As an embedded-system programmer myself, I have daily phone or BBS contact with inventors, scientists, designers, and engineers eager to acquire a working knowledge of Forth. They all have come to the conclusion that, like it or not, they must learn Forth to get the job done in reasonable time for a reasonable investment of cash.

A class I teach in Golden, Colorado continues to gain new attendees, individuals who have discovered Forth on their own and seek tutoring in the basics.

An admittedly unscientific and subjective assessment of job opportunities for Forth programmers leads me to believe that there have never been more positions for qualified individuals in the history of Forth, nor have so many of these positions ever gone begging for so long. Furthermore, Forth is reaching higher in the corporate world; for example, IBM here in Colorado is committing major programmer effort to the Forth-coded IBM-CAD project.

Yet those of us who enjoy the FIG fellowship must find it subject for concern that this "Greening of Forth" does not seem to be entirely reflected in the Forth Interest Group. Membership has certainly not increased in proportion to the Forth boom; rather, we find old members too busy to participate any longer, often less enchanted with *Forth Dimensions*, occasionally disgruntled at actions, or lack of same, from the FIG leadership.

To a certain extent, this falling away from FIG is limited to North America. I am informed by telecom friends in Europe and Australia that new Forth Interest Group chapters are constantly being formed, and that the chapters that exist are lively and well attended. Recently, we certified the first chapter in Finland, with a second possibly to follow; new applications have reached Kent and Jan in the business office from as far away as Bulgaria!

If FIG indeed is currently in decline, what could be the reasons?

First of all, the institution of the Saturday computer club is in decline in North America. Computer savvy goes crying in the streets nowadays; we are surrounded by all the digital wizardry we could desire and more; the beginner does not need as much hand-holding from monthly meetings as before, since the sophistication of even the most casual computer user is far greater than that of ten years ago.

Secondly, while FIG has made one bold stride in the direction of the brave new world by opening the Forth Interest Group RoundTable on GEnie, other services are needed by the modern Forth programmer that FIG has not yet been able or seen fit to provide. It may yet be that other organizations will step in to fill the vacuum, such as the Association for Computation Machinery's SIG-Forth, which sees itself as a natural forum for the professional Forth programmer.

Also, FIG has been drifting slightly under the influence of a quite natural process of new faces coming into the organization to replace experienced hands, your correspondent finding himself among the former culpable grouping.

Many suggestions have been offered, many plans have been laid for the continuation of the work of the Forth Interest Group. Those interested in summaries of these suggestions, or in making suggestions of their own, will find the most ready audience waiting in the various telecom institutions growing up with Forth—see the "Reference Section" elsewhere in this issue. Furthermore, any chapter can subscribe to our monthly Chapters Newsletter by contacting me on any of those services or at my UUCP address of jax@well.UUCP, well!jax@lll-winken.arpa, or alternatively by shouting for my attention on USENET's comp.lang.forth discussion group.

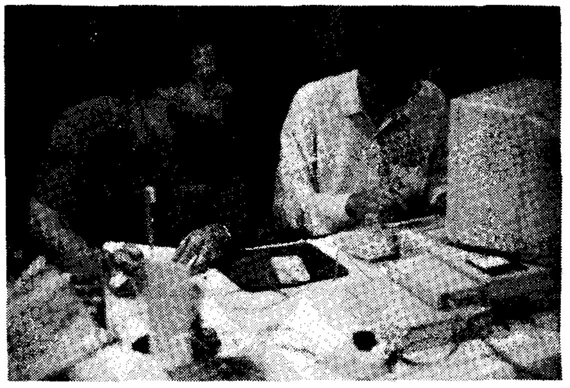
Your Chapter Coordinator's personal offering to the FIG suggestion box is tried, trite, and true: the future is in the hands of youth. FIG has yet to try a major outreach to high schools in every city in the world where there exists a FIG chapter. IMHO (as we say in telecom) such a framework for the propagandization of the youthful entrant to the digital universe is long overdue.

I feel very optimistic about FIG. The Forth Interest Group, in particular the Silicon Valley FIG Chapter, was instrumental in my entry into the world of Forth. Furthermore, since May 1987, I have held three consecutive full-time Forth programming positions, two obtained through FIG meetings, the latest and current position here in Colorado found in the "Programmer Wanted" ads on the GEnie FIG RT.

I see no reason why the Forth Interest Group cannot continue to offer a friendly and helpful gateway to Forth for the beginner while serving the changing and varied needs of the professional. Innovation and dedication will be required from the members of the world's oldest fraternal association of Forth programmers, which will no doubt be available in abundance, since are not innovation and dedication the very hallmarks of the Forth programmer?

1988 PROGRAMMERS CONTEST

Held at last year's FIG-sponsored "Real-Time Programming Convention," this event captured the spirit of the Forth programmer confronted with an unusual problem. The object of the contest was a closely held secret until the event began.



Winners of the contest were Phil Burk and Mike Haas from Delta Research.

FIG CHAPTERS

The FIG Chapters listed below are currently registered as active with regular meetings. If your chapter listing is missing or incorrect, please contact Kent Safford at the FIG office's Chapter Desk. This listing will be updated in each issue of *Forth Dimensions*. If you would like to begin a FIG Chapter in your area, write for a "Chapter Kit and Application." Forth Interest Group, **P.O. Box 8231, San Jose, California 95155**

U.S.A.

- **ALABAMA**
  Huntsville Chapter
  Tom Konantz
  (205) 881-6483

- **ALASKA**
  Kodiak Area Chapter
  Horace Simmons
  (907) 486-5049

- **ARIZONA**
  Phoenix Chapter
  4th Thurs., 7:30 p.m.
  AZ State University
  Memorial Union, 2nd floor
  Dennis L. Wilson
  (602) 956-7578

- **ARKANSAS**
  Central Arkansas Chapter
  Little Rock
  2nd Sat., 2 p.m. &
  4th Wed., 7 p.m.
  Jungkind Photo, 12th & Main
  Gary Smith (501) 227-7817

- **CALIFORNIA**
  Los Angeles Chapter
  4th Sat., 10 a.m.
  Hawthorne Public Library
  12700 S. Grevillea Ave.
  Phillip Wasson
  (213) 649-1428

  North Bay Chapter
  2nd Sat., 10 a.m. Forth, AI
  12 Noon Tutorial, 1 p.m. Forth
  South Berkeley Public Library
  George Shaw (415) 276-5953

  Orange County Chapter
  4th Wed., 7 p.m.
  Fullerton Savings
  Huntington Beach
  Noshir Jesung (714) 842-3032

  Sacramento Chapter
  4th Wed., 7 p.m.
  1708-59th St., Room A
  Tom Ghormley
  (916) 444-7775

  San Diego Chapter
  Thursdays, 12 Noon
  Guy Kelly (619) 454-1307

  Silicon Valley Chapter
  4th Sat., 10 a.m.
  H-P Cupertino
  Bob Barr (408) 435-1616

  Stockton Chapter
  Doug Dillon (209) 931-2448

- **COLORADO**
  Denver Chapter
  1st Mon., 7 p.m.
  Clifford King (303) 693-3413

- **CONNECTICUT**
  Central Connecticut Chapter
  Charles Krajewski
  (203) 344-9996

- **FLORIDA**
  Orlando Chapter
  Every other Wed., 8 p.m.
  Herman B. Gibson
  (305) 855-4790

  Southeast Florida Chapter
  Coconut Grove Area
  John Forsberg (305) 252-0108

  Tampa Bay Chapter
  1st Wed., 7:30 p.m.
  Terry McNay (813) 725-1245

- **GEORGIA**
  Atlanta Chapter
  3rd Tues., 6:30 p.m.
  Western Sizzlen, Doraville
  Nick Hennenfent
  (404) 393-3010

- **ILLINOIS**
  Cache Forth Chapter
  Oak Park
  Clyde W. Phillips, Jr.
  (312) 386-3147

  Central Illinois Chapter
  Champaign
  Robert Illyes (217) 359-6039

- **INDIANA**
  Fort Wayne Chapter
  2nd Tues., 7 p.m.
  I/P Univ. Campus, B71 Neff Hall
  Blair MacDermid
  (219) 749-2042

- **IOWA**
  Central Iowa FIG Chapter
  1st Tues., 7:30 p.m.
  Iowa State Univ., 214 Comp. Sci.
  Rodrick Eldridge
  (515) 294-5659

  Fairfield FIG Chapter
  4th Day, 8:15 p.m.
  Gurdy Leete (515) 472-7077

- **MARYLAND**
  MDFIG
  Michael Nemeth
  (301) 262-8140

- **MASSACHUSETTS**
  Boston Chapter
  3rd Wed., 7 p.m.
  Honeywell
  300 Concord, Billerica
  Gary Chanson (617) 527-7206

- **MICHIGAN**
  Detroit/Ann Arbor Area
  4th Thurs.
  Tom Chrapkiewicz
  (313) 322-7862

- **MINNESOTA**
  MNFIG Chapter
  Minneapolis
  Even Month, 1st Mon., 7:30 p.m.
  Odd Month, 1st Sat., 9:30 a.m.
  Fred Olson (612) 588-9532
  NC Forth BBS (612) 483-6711

- **MISSOURI**
  Kansas City Chapter
  4th Tues., 7 p.m.
  Midwest Research Institute
  MAG Conference Center
  Linus Orth (913) 236-9189

  St. Louis Chapter
  1st Tues., 7 p.m.
  Thornhill Branch Library
  Robert Washam
  91 Weis Drive
  Ellisville, MO 63011

- **NEW JERSEY**
  New Jersey Chapter
  Rutgers Univ., Piscataway
  Nicholas Lordi
  (201) 338-9363

- **NEW MEXICO**
  Albuquerque Chapter
  1st Thurs., 7:30 p.m.
  Physics & Astronomy Bldg.
  Univ. of New Mexico
  Jon Bryan (505) 298-3292

- **NEW YORK**
  FIG, New York
  2nd Wed., 7:45 p.m.
  Manhattan
  Ron Martinez (212) 866-1157

  Rochester Chapter
  Odd month, 4th Sat., 1 p.m.
  Monroe Comm. College
  Bldg. 7, Rm.102
  Frank Lanzafame
  (716) 482-3398

- **OHIO**
  Cleveland Chapter
  4th Tues., 7 p.m.
  Chagrin Falls Library
  Gary Bergstrom
  (216) 247-2492

  Columbus FIG Chapter
  Terry Webb
  (614) 878-7241

  Dayton Chapter
  2nd Tues. & 4th Wed., 6:30 p.m.
  CFC. 11 W. Monument Ave. #612
  Gary Ganger (513) 849-1483

- **OREGON**
  Willamette Valley Chapter
  4th Tues., 7 p.m.
  Linn-Benton Comm. College
  Pann McCuaig (503) 752-5113

- **PENNSYLVANIA**
  Villanova Univ. FIG Chapter
  Bryan Stueben
  321-C Willowbrook Drive
  Jeffersonville, PA 19403
  (215) 265-3832

- **TENNESSEE**
  East Tennessee Chapter
  Oak Ridge
  3rd Tues., 7 p.m.
  Sci. Appl. Int'l. Corp., 8th Fl
  800 Oak Ridge Turnpike
  Richard Secrist
  (615) 689-8161

- **TEXAS**
  Austin Chapter
  Matt Lawrence
  PO Box 180409
  Austin, TX 78718

  Dallas Chapter
  4th Thurs., 7:30 p.m.
  Texas Instruments
  13500 N. Central Expwy.
  Semiconductor Cafeteria
  Conference Room A
  Clif Penn (214) 995-2361

  Houston Chapter
  3rd Mon., 7:45 p.m.
  Intro Class 6:30 p.m.
  Univ. at St. Thomas
  Russell Harris (713) 461-1618

- **VERMONT**
  Vermont Chapter
  Vergennes
  3rd Mon., 7:30 p.m.
  Vergennes Union High School
  RM 210, Monkton Rd.
  Hal Clark (802) 453-4442

- **VIRGINIA**
  First Forth of Hampton Roads
  William Edmonds
  (804) 898-4099

  Potomac FIG
  D.C. & Northern Virginia
  1st Tues.
  Lee Recreation Center
  5722 Lee Hwy., Arlington
  Joseph Brown
  (703) 471-4409
  E. Coast Forth Board
  (703) 442-8695

  Richmond Forth Group
  2nd Wed., 7 p.m.
  154 Business School
  Univ. of Richmond
  Donald A. Full
  (804) 739-3623

- **WISCONSIN**
  Lake Superior Chapter
  2nd Fri., 7:30 p.m.
  1219 N. 21st St., Superior
  Allen Anway (715) 394-4061

INTERNATIONAL

- **AUSTRALIA**
  Melbourne Chapter
  1st Fri., 8 p.m.
  Lance Collins
  65 Martin Road
  Glen Iris, Victoria 3146
  03/29-2600
  BBS: 61 3 299 1787

  Sydney Chapter
  2nd Fri., 7 p.m.
  John Goodsell Bldg., RM LG19
  Univ. of New South Wales
  Peter Tregeagle
  10 Binda Rd., Yowie Bay
  2228
  02/524-7490

- **BELGIUM**
  Belgium Chapter
  4th Wed., 8 p.m.
  Luk Van Loock
  Lariksdreff 20
  2120 Schoten
  03/658-6343

  Southern Belgium Chapter
  Jean-Marc Bertinchamps
  Rue N. Monnom, 2
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- **CANADA**
  BC FIG
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  BCIT, 3700 Willingdon Ave.
  BBY, Rm. 1A-324
  Jack W. Brown (604) 596-9764
  BBS (604) 434-5886

  Northern Alberta Chapter
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  Tony Van Muyden
  (403) 486-6666 (days)
  (403) 962-2203 (eves.)

  Southern Ontario Chapter
  Quarterly, 1st Sat., Mar., Jun., Sep., Dec., 2 p.m.
  Genl. Sci. Bldg., RM 212
  McMaster University
  Dr. N. Solntseff
  (416) 525-9140 x3443

- **ENGLAND**
  Forth Interest Group-UK
  London
  1st Thurs., 7 p.m.
  Polytechnic of South Bank
  RM 408
  Borough Rd.
  D.J. Neale
  58 Woodland Way
  Morden, Surry SM4 4DS

- **FINLAND**
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  Janne Kotiranta
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  33720 Tampere
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- **HOLLAND**
  Holland Chapter
  Vic Van de Zande
  Finmark 7
  3831 JE Leusden

- **ITALY**
  FIG Italia
  Marco Tausel
  Via Gerolamo Forni 48
  20161 Milano
  02/435249

- **JAPAN**
  Japan Chapter
  Toshi Inoue
  Dept. of Mineral Dev. Eng.
  University of Tokyo
  7-3-1 Hongo, Bunkyo 113
  812-2111 x7073

- **NORWAY**
  Bergen Chapter
  Kjell Birger Faeraas,
  47-518-7784

- **REPUBLIC OF CHINA**
  R.O.C. Chapter
  Chin-Fu Liu
  5F, #10, Alley 5, Lane 107
  Fu-Hsin S. Rd. Sec. 1
  TaiPei, Taiwan 10639

- **SWEDEN**
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  Per Alm
  46/8-929631

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