Forth to the IRS

EuroForth 98 Conference

Two Problems in ANS Forth

Safer Numeric Input

Finite State Machines
Greetings from the FIG office!
This is the year the FORML Conference turns 20! What a milestone. We already have participants giving us titles for the talks they are planning to present. If you’d like to see what we’ve got lined up, just log on to the Forth Interest Group web site (www.forth.org), scroll to Forth Conferences, and there you have it. By now, you should have received a purple flyer with the FORML registration information. If not, you can check our web site for that information, too, or contact the office and we will be happy to mail, fax, or e-mail the registration information to you. In addition to the regular registration, there are three levels of increased financial sponsorship for FORML available: Bronze, Silver, and Gold. If you or your company would like to become a FORML sponsor, and/or have equipment and/or services you would like to offer, please contact the office and we will give you the details. We are looking forward to seeing you in November!

The Forth Interest Group is kept running with your membership dues and kind donations. We continue to add new members every month; however, we also lose members. We need your help to steadily increase our membership. If you do have friends or colleagues who are interested in joining, please contact us at the office and we will be happy to send membership information along with a complimentary issue of Forth Dimensions for their review.

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And remember—together we can make a difference!

Cheers,

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**Finite State Machines in Forth**  
*by Julian V. Noble*

Certain programming problems are simpler to solve using abstract finite state machines. This paper provides methods for constructing deterministic and non-deterministic finite state automata in Forth. The “best” method produces a one-to-one relation between the definition and the state table of the automaton. An important feature of the technique is the absence of (slow) nested IF clauses.

**Safer Numeric Input**  
*by Jerry Avins*

“Safety” is, perhaps, something many programmers don’t have to worry about. But when your embedded system is controlling a medical device or a piece of heavy machinery, such concerns become paramount. Specialists in the field know there are many aspects to the subject; this article addresses one concern—that the operator’s display accurately represent the data the program is using.

**EXPRESS Factory Control**  
*by Allen Anway*

EXPRESS is a Forth-based system for running machinery or a factory. Its specialty is real-time performance. This application runs four lime kilns. In this case, EXPRESS works in concert with Programmable Logic Controllers (PLCs) distributed at various use sites throughout the plant.

**Forth to the IRS**  
*by Len Zettel*

The annual U.S. tax-filing ritual brings great stress as the April 15 deadline mars an otherwise lovely time of year. We can file extensions and go through the emotional trauma again in a few months, or do as this author did, and dilute the dread with the pleasure of Forth programming...

**Report: EuroForth 1998 Conference**  
*by Paul E. Bennett*

Forth might have nominal roots in the United States, but it migrated to Europe almost immediately. It has strong supporters and developers there, and many significant applications. The annual Forth conference is the primary venue of intellectual exchange and camaraderie among Forth users in Europe.

**Two Problems in ANS Forth**  
*by Thomas Worthington*

The author addresses his concerns about potential problems in ANS Forth: colon-sys on the control-flow stack, and the inability of the programmer to assign the input stream to an arbitrary block of memory. The problems are described along with solutions—which present a bonus benefit.
ANS Forth Revisited

As promised in our last issue, this time we introduce refereed material from the Journal of Forth Applications and Research. Since JEAR has gone electronic, we anticipate that FD will be the primary printed source of its refereed Forth articles. It is with special pleasure that we inaugurate this series with Julian V. Noble's "Finite State Machines in Forth," and we look forward to presenting equally informative and challenging material in the future.

ANS Forth, and its ISO/IEC equivalent, has enjoyed a surprisingly smooth road to general acceptance. Those who remember some of the past tumult over standards had predicted more difficulty. This is not to say that it has been adopted universally. The standard has not been entirely without detractors, and even its proponents will mention things which would be useful in the standard but which could not be agreed upon at the time it was passed.

But I believe most people recognize that the standard is both a good way for us to communicate among ourselves, to formalize standard practice, and to achieve some greater degree of legitimacy in the world of business. The ANS effort was first discussed at a FORML Conference and, at this year's conference, the standard will be re-opened for evaluation and possible revision. Participants are welcome, and FD naturally will report the details.

Meanwhile, as we continue striving to accelerate our publishing schedule in order to get our issues out on time, please enjoy this issue's content—and let the included writers guidelines inspire you to help us by sharing your own discoveries, opinions, and techniques with your fellow readers. I'll look forward to hearing from you.

—Marlin Ouverson, Editor

...Forth programs should have a tab indent of 40 spaces. That way we won't be tempted to write huge multi-level control structures, and will want to factor a little.

—Andrew McKewan
(from comp.lang.forth)

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Finite State Machines in Forth

This note provides methods for constructing deterministic and non-deterministic finite state automata in Forth. The "best" method produces a one-to-one relation between the definition and the state table of the automaton. An important feature of the technique is the absence of (slow) nested IF clauses.

1. Introduction

Certain programming problems are difficult to solve procedurally even using structured code, but simple to solve using abstract finite state machines (FSMs) [1]. For example, a compiler must distinguish a text string representing, say, a floating-point number, from an algebraic expression that might well contain similar characters in similar order. Or a machine controller must select responses to predetermined inputs that occur in random order.

Such problems are interesting because a program that responds to indefinite input is closer to a "thinking machine" than a mere sequential program. Thus, a string that represents a floating-point number is defined by a set of rules; it has no definite length, nor do the symbols appear in a definite order. Worse, more than one form for the same number may be permissible—user-friendliness demands a certain flexibility of format.

Although generic pattern recognition can be implemented through logical expressions (i.e., by concatenating sufficiently many IFs, ELSEs, and THENs) the resulting code is generally hard to read, debug, or modify. Worse, this approach is anything but structured, no matter how "pretty" the code is laid out: indentation can only do so much. And programs consisting mainly of logical expressions can be slow, because many processors dump their pipelines upon branching [2]. These defects of the nested-IF approach are attenuated by the profusion of commercial tools to overcome them: Stirling Castle's Logic Gem (that translates and simplifies logical expressions), Matrix Software's Matrix Layout (that translates a tabular representation of an FSM into one of several languages such as BASIC, Modula-2, Pascal, or C), or AYECO, Inc.'s COMPEDITOR (that performs a similar translation). [These CASE tools were available at least as recently as 1993 from The Programmer's Shop and other developer-oriented software discounters.]

Forth is a particularly well-structured language that encourages natural, readable ways to generate FSMs. This note describes several high-level Forth implementations. Finite state machines have been discussed previously in this journal [3, 4]. The present approach improves on prior methods.

2. A Simple Example

Consider the task of accepting numerical input from the keyboard. An unfriendly program lets the user enter the entire number before informing him that he typed two decimal points after the first digit. A friendly program, by contrast, refuses to recognize or display illegal characters. It waits instead for a legal character or carriage return (signifying the end of input). It permits backtracking, allowing erasure of incorrect input.

To keep the example small, our number-input routine allows signed decimal numbers without power-of-10 exponents (fixed point, in FORTRAN parlance). Decimal points, numerals, and leading minus signs are legal, but no other ASCII characters (including spaces) will be recognized. Here are some examples of legal numbers:

```
0.123, .123, 1.23, -1.23, 123, etc.
```

From these examples we derive the rules:

* Characters other than 0-9, -, and . are illegal.
* Numerals 0-9 are legal.
* The first character can be -, 0-9, or a decimal point.
* After the first character, - is illegal.
* After the first decimal point, decimal points are illegal.

A traditional procedural approach might look something like Listing One.

### Listing One

```forth
VARIABLE PREVIOUS.MINUS? \ history semaphores
VARIABLE PREVIOUS.DP?

: FIRST.MINUS?  MINUS? PREVIOUS.MINUS? @ NOT AND ;
: FIRST.DP?    DP?  PREVIOUS.DP? @ NOT AND ;
: LEGAL?       ( c -- f ) ASCII - = ;

: DIGIT?       ( c -- f ) ASCII 0 ASCII 9 WITHIN ; \ tests
: DP?          ( c -- f ) ASCII . = ;
: MINUS?       ( c -- f ) ASCII - = ;

DUP DIGIT?
IF DROP TRUE DUP PREVIOUS.MINUS? ! .ELSE DUP FIRST.MINUS?
IF DROP TRUE DUP PREVIOUS.MINUS? !
ELSE FIRST.DP?
IF NOT TRUE DUP PREVIOUS.DP? !
ELSE FALSE THEN
THEN
```

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Copyright © 1995 Institute for Applied Forth Research, Inc. All rights reserved. First published in the electronic version of the Journal of Forth Application and Research (www.jfar.org).
The word that does the work (with apologies to Uderzo and Goscinny, creators of Asterix) is shown in Listing Two. What makes this example—whose analogs appear frequently in published code in virtually every language—horrible? Each character whose legality is time-dependent requires a history semaphore. It is therefore difficult to tell by inspection that the word $\text{LEGAL?}$’s logic is actually incorrect, despite the simplification obtained by partial factoring and logical arithmetic.

3. Forth Finite State Machines

The FSM approach replaces the true/false historical semaphores with one state variable. The rules can be embodied in a state table that expresses the response to each possible input in terms of a concrete action and a state transition, as shown in Figure One.

In the state table,
- The illegality of "other" characters is expressed by the uniform action $X$ and the absence of state transitions. 
- The special status of the first character is expressed by the fact that all acceptable characters lead to transitions out of the initial state $(0)$. 
- An initial - sign or digit leads to state 1, where a - sign is unacceptable. 
- A decimal point always moves the system to state 2, where decimal points are not accepted.

While some FSMs can be synthesized with $\text{BEGIN ... WHILE ... REPEAT or BEGIN ... UNTIL}$ loops, keyboard input does not readily lend itself to this approach. We now explore three implementations of the state table of Figure One as Forth FSMs.

3.1. Brute-Force FSM

The "brute-force" FSM uses the Eaker $\text{CASE}$ statement, either in its original form [5] or with a simplified construct from HS/Forth [6]. HS/Forth provides defining words $\text{CASE}: \ldots ; \text{CASE}$ whose daughter words execute one of several words in their definition, as in:

$$\text{CASE:}$$
$$\text{CHOICE \WORD0 \WORD1 \WORD2 \WORD3 \ldots \WORDn}$$
$$\text{;CASE}$$
$$\text{3 \CHOICE ( executes \WORD3 ) ok}$$

3.2. A Better FSM

While the approach outlined above in §3.1 (essentially the method described recently by Berrian [8]) both works and produces much clearer code than the binary logic tree of §2, it nevertheless can be improved. The words $(0)$, $(1)$, and $(2)$ are inadequately factored (they contain the tests performed on the input character). They also contain $\text{IF ... ELSE ... THEN}$ branches (which we prefer to avoid for the sake of speed and structure). Finally, each FSM must be hand crafted from numerous subsidiary definitions.

We want to translate the state table in Figure One into a program. The preceding attempt was too indirect—each state was represented by its own word that did too much. Perhaps we can achieve the desired simplicity by translating more directly. In Forth, such translations are most naturally accomplished via defining words. Suppose we visualize the state table as a matrix, whose cells contain action specifications (addresses or execution tokens), whose columns represent input categories, and whose rows are states. If we translate input categories to column numbers, the category and the current value of the state variable (row index) determine a unique cell address, whose content can be fetched and executed.

Translating the input to a column number factors the tests into a single word that executes once per character. This word should avoid time-wasting branching instructions, so all decisions (as to which cell of the table to EXECUTE) will be computed rather than decided. For our test example, the preliminary definitions are given in Listing Six and the input translation is carried out by the definitions in Listing Seven.

Now we must plan the state-table compiler. In general, we define an action word for each cell of the table that will perform the required action and state change. At compile time,
the defining word will compile an array of the execution addresses (execution tokens in ANS-Forth parlance [9]) of these action words. At run time, the child word computes the address of the appropriate matrix cell from the user-supplied column number and the current value of mystate, fetches the execution address from its matrix cell, and executes the appropriate action. Since a table can have arbitrarily many columns, the number of columns must be supplied at compile time. These requirements lead to the definitions in Listing Eight.

Here CREATE makes a new header in the dictionary, stores the top number on the stack in the first cell of the parameter field, and switches to compile mode. The run-time code computes the address of the cell containing the vector to the desired action, fetches that vector, and executes the action. [Note: This simple and elegant implementation only works with indirect-threaded Forths. An ANSI Standard alternative is provided in the Appendix.]

Now we apply this powerful new word to our example problem. From Figure One we see that transitions (changes of state) occur only in cells (0,0), @, (0,2), (1,0), and (1,2). These are always associated with EMIT (E in the figure). No change of state accompanies a wrong input, and the associated action is to DROP the character. There are, thus, only two distinct state-changing actions we need define:

Listing Seven

: cat->col# ( n -- n' )
  DUP DIGIT? 1 AND      
  OVER MINUS? 2 AND +  
  SWAP DP? 3 AND +      
  ;       
  \ digit -> 1
  \ -   -> 2
  \ dp   -> 3
  \ other -> 0

Since we must test for four conditions on the input character, the state table will be four columns wide:

Listing Eight

: TUCK   COMPILE UNDER ;   \ ANS compatibility
: WIDE   \ NOOP for clarity
: CELLS  \ ANS compatibility
: CELL+  \ ANS compatibility
: PERFORM \ alias
: FSM:   \ ( width -- ) CREATE , ]
  DOES> ( n adr -- )
  TUCK @ mystate @ * + CELLS CELL+ +
  ( adr') PERFORM ;
<table>
<thead>
<tr>
<th>4 WIDE FSM: &lt;Fixed.Pt#&gt; ( action# -- )</th>
</tr>
</thead>
<tbody>
<tr>
<td>\ other num - . \ state</td>
</tr>
<tr>
<td>DROP (00) (00) (02) \ 0</td>
</tr>
<tr>
<td>DROP (00) DROP (02) \ 1</td>
</tr>
<tr>
<td>DROP (02) DROP DROP ; \ 2</td>
</tr>
</tbody>
</table>

The word that does the work is:

```forth
: Getafix
0 mystate !
BEGIN KEY DUP 13 <> \ not CR
WHILE DUP cat->col# <Fixed.Pt#> REPEAT ;
```

We can immediately test the FSM, as follows:

```forth
FLOAD F:X.1 Loading F:X.1 ok
ASCII 3 cat->col# . 1 ok
ASCII 0 cat->col# . 1 ok
ASCII - cat->col# . 2 ok
ASCII . cat->col# . 3 ok
ASCII A cat->col# . 0 ok
```

The incorrect input of excess decimal points, incorrect minus signs, or non-numeric characters does not show because, as intended, they were dropped without echoing to the screen.

### 3.3. An Elegant FSM

The defining word `FSM`: of §3.2, while useful, nevertheless has room for improvement. This version hides the state transitions within the action words compiled into the child word's cells. A more thoroughly factored approach would explicitly specify transitions next to the actions they follow, within the definitions of each FSM. Definitions will become more readable, since each looks just like its state table; that is, our ideal FSM definition will look like Listing Nine, so we would never need the words `(00)` and `(02)`. Fortunately, it is not hard to redefine `FSM` to include the transitions explicitly. We may use `CONSTANTS` to effect the state transitions:

```forth
0 CONSTANT >0
1 CONSTANT >1
2 CONSTANT >2
```

and modify the run time portion of `FSM`: accordingly (Listing Ten).

Note that we have defined the run-time code so that the change in state variable precedes the run-time action. Sometimes the desired action is an `ABORT` and an error message. Changing the state variable first lets us avoid having to write a separate error handler for each cell of the FSM, yet we can tell where the `ABORT` took place. If the `ABORT` were first, the state would not have been updated.

The FSM is then defined as in Listing Eleven, which is clear and readable. Of course, one could define the run-time `(DOES>` portion of `FSM`: to avoid the need for extra `CONSTANTS` `0`, `1`, etc. The actual numbers could be stored in the table via the code in Listing Twelve.

However, for reasons given in §4 below, it is better to implement the state transition with `CONSTANTS` rather than with numeric literals.

### 4. The Best FSM So Far

Experience using the FSM approach to write programs has motivated two further improvements. First, suppose one needs to nest FSMs, i.e., to compile one into another, or even to recurse. The global variable `mystate` precludes such fineness. It therefore makes sense to include the state variable for each FSM in its data structure, just as with its `WIDTH`. This modification protects the state of an FSM from any accidental interactions, at the cost of one more memory cell per FSM, since if the state has no name it cannot be invoked. Second, suppose one or other of the action words is supposed to leave something on the stack, and that, for some reason, it is desirable to alter the state after the action rather than before (this is, in fact, the more natural order of doing things). Since there is no way to know in advance what the stack effect will be, we use the return stack for temporary storage, to avoid collisions. The revision is, thus, as shown in Listing Thirteen.

The revised keyboard input word of our example is:

```forth
: Getafix
0 mystate !
BEGIN KEY DUP 13 <> WHILE
DUP cat->col# <Fixed.Pt#> REPEAT ; ok
Getafix -3.1415975 ok
Getafix 55.3259 ok
```

The state variable is initialized to zero because we know it is stored in the first cell in the parameter field of the FSM which can be accessed by the phrase `'< Fixed.Pt#>` (or the equivalent in the Forth dialect being used—see Appendix).

### 5. Non-deterministic Finite State Machines

We are now in a position to explain why defining a `CONSTANT` to manage the state transitions is better than merely incorporating the next state's number. First, there is no obvious reason why states cannot be named rather than numbered. The Forth outer interpreter itself is a state machine with two states, `COMPILE` and `INTERPRET`; i.e., names are often clearer than numbers.

The use of a word rather than a number to effect the transition permits a more far-reaching modification. Our code defines a compiler for deterministic FSMs, in which each cell in the table contains a transition to a definite next state. What if we allowed branching to any of several next states, following a given action? FSMs that can do this are called non-deterministic. Despite the nomenclature, and despite the misleading descriptions of such FSMs occasionally found in the literature [10], there need be nothing random or "guess-like" about the next transition. What permits multiple possibilities is additional information, external to the current state and current input.

Here is a simple non-deterministic FSM used in my FORmula TRANslator [11]. The problem is to determine whether a piece of text is a proper identifier (that is, the name of a variable, subroutine, or function) according to the rules
of FORTRAN. An ID must begin with a letter, and can be up to seven characters long, with characters that are letters or digits. To accelerate the process of determining whether an ASCII character code represents a letter, digit, or "other," we define a decoder (fast table translator):
and a method to fill it quickly:

```
: install ( col# adr char.n char.1 -- )
\ fast fill
SWAP 1+ SWAP
DO DDUP I + C! LOOP DDROP ;
```

The translation table we need for detecting IDs is

```
128 \TAB: [id]
1 ' [id] ASCII Z ASCII A install
1 ' [id] ASCII z ASCII a install
2 ' [id] ASCII 9 ASCII 0 install
```

This follows the Forth-79 convention that ' returns the PFA. To convert to Forth-83 or ANS, replace ' by ' >BODY. Thus, e.g.: ASCII R [id] . 1 ok ASCII s [id] . 1 ok ASCII 3 [id] . 2 ok ASCII + [id] . 0 ok \ to convert to ANSI replace ASCII by CHAR

Now how do we embody the ID rules in an FSM? Our first attempt might look like Listing Fourteen.

To make sure the id is at most seven characters long, we had to provide eight states. The table is rather repetitious. A simpler alternative uses a VARIABLE to count the characters as they come in. The revision is shown in Listing Fifteen.

The resulting FSM is non-deterministic because the word >12? induces a transition either to state 1 or to (the terminal) state 2. It has fewer states and consumes less memory, despite the extra definitions. Because we have stuck to subroutines for mediating state transitions, going from a definite transition (via a CONSTANT such as >0 or >1) to an indefinite one requires no redefinitions.

The FSM in Figure Sixteen detects properly formed floating-point numbers. The FSM (fp#) does not count digits in the mantissa, but limits those in the exponent to two or fewer. A non-deterministic version of (fp#) reduces the number of states, while counting digits in both the mantissa and exponent of the number (Listing Seventeen).

The task of fleshing out the details—specifically, the words +mant, +exp, +1, >0?, >1?, and >3?—is left as an exercise for the reader.

6. Acknowledgments

I am grateful to Rick Van Norman and Lloyd Prentice for positive feedback about applications of the FSM compiler in areas as diverse as gas pipeline control and educational computer games.

7. Appendix

Here is a high-level definition of the HS/Forth CASE: ...;CASE (albeit it imposes more overhead than HS/Forth's version) that works in indirect-threaded systems:

```
: CASE:\nCREATE [ \nDOES> ( n -- ) OVER ++ @ EXECUTE ;

: ;CASE [ COMPILE] ;
\ IMMEDIATE ( or just use ; )
```

However, it will not work with a direct-threaded Forth like F-PC. It fails because what is normally compiled into the body of the definition (by using \) to turn on the compiler) in a direct-threaded system is not a list of execution tokens. The simplest alternative (it also works with indirect-threaded systems) factors the compilation function out of CASE:

```
: CASE: CREATE ;
\| ' , ; \ F83 and ANS version
: ;CASE \ no error checking
\ DOES> OVER ++ PERFORM ;
```

Here is a usage example:

```
CASE: TEST | * | / | + | - \ CASE
3 4 0 TEST . <u>12 ok</u>
12 4 1 TEST . <u>3 ok</u>
5 7 2 TEST . <u>12 ok</u>
5 7 3 TEST . <u>-2 ok</u>
```

Although the CASE statement can be made to extend over several lines if one likes, readability and good factoring suggest such definitions be kept short.

The same technique can be used to provide a version of FSM that works with F-PC and other F83-based or ANS-compliant systems, for those who want to experiment with FSM: but lack HS/Forth to try the version §4 with. The definitions are:

```
: | ' , ; \ F83 and ANS version
: ;FSM \WIDTH 0 ;
```

```
: FSM: ( width 0 -- ) CREATE , , ;
; : FSM DOES> ( col# adr -- )
DUP \R 2@ * + ( -- col#width*state )
2* 2+ CELLS ( -- offset-to-action )
DUP \R ( -- offset-to-action )
\ PERFORM ( ? )
\ R> CELL+ ( -- offset-to-update )
\ PERFORM ( -- state' )
\ R> ! \ ( ? ) \ update state
```

The FSM of §3.3 now takes the form of Listing Eighteen.

8. References


Listing Fourteen

3 WIDE FSM: (id)
\ input: | other | letter | digit |
\ state  ------------------------------
 (0)     NOOP>2 1+>1 NOOP>2
 (1)     NOOP>2 1+>2 1+>2
 (2)     NOOP>2 1+>3 1+>3
 (3)     NOOP>2 1+>4 1+>4
 (4)     NOOP>2 1+>5 1+>5
 (5)     NOOP>2 1+>6 1+>6
 (6)     NOOP>2 1+>7 1+>7
 (7)     NOOP>2 NOOP>8 NOOP>8 ;

: state<                                    
    [COMPILE] ' LITERAL ; IMMEDIATE

\ compile address of "state" cell of a FSM
\ for F83 or ANS replace ' with >BODY

:id> ( Send $beg -- f)
0 state< (id)!
BEGIN DUP C@ [id] (id)
   DDUP>
   state< (id) @ 2 <
   AND
   WHILE 1+
   REPEAT DDROP
   state< (id) @ 8 < ;

Listing Fifteen

VARIABLE id.len 0 id.len ! ; \ increment counter
:+id.len id.len @ 1+ id.len ! ; \ if id.len < 7, 2 otherwise
:id> ( Send $beg -- f)
0 id.len ! 0 state< (id)!
BEGIN DUP C@ [id] (id)
   DDUP>
   state< (id) @ 2 <
   AND
   WHILE 1+
   REPEAT DDROP
   state< (id) @ 1 = ;

Forth Dimensions XX.2
Listing Sixteen

128 TAB: [ fp# ] \ decoder for fp#
1 ' [ fp# ] ASCII E ASCII D install
1 ' [ fp# ] ASCII e ASCII d install
2 ' [ fp# ] ASCII 9 ASCII 0 install
3 ' [ fp# ] ASCII + + C!
3 ' [ fp# ] ASCII - - C!
4 ' [ fp# ] ASCII . + C!

: #err CRT \ restore normal output
" Not a correctly formed fp#" ABORT ; \ fp# error handler

5 WIDE FSM: (fp#)
\ input: | other | dDeE | digit | + or - | dp |
\ state: ..............................................................
( 0 ) NOOP >6 NOOP >6 1+ >0 NOOP >6 1+ >1
( 1 ) NOOP >6 1+ >2 1+ >1 #err >6 #err >6
( 2 ) NOOP >6 #err >6 NOOP >4 1+ >3 #err >6
( 3 ) NOOP >6 #err >6 1+ >4 #err >6 #err >6
( 4 ) NOOP >6 #err >6 1+ >5 #err >6 #err >6
( 5 ) NOOP >6 #err >6 #err >6 #err >6 ;

Listing Seventeen

5 WIDE FSM: (fp#)
\ input: | other | dDeE | digit | + or - | dp |
\ state: ..............................................................
( 0 ) NOOP >4 NOOP >4 +mant >0? NOOP >4 1+ >1
( 1 ) NOOP >4 ?1+ >2 +mant >1? #err >4 #err >4
( 2 ) NOOP >4 #err >4 +exp >3 1+ >3 #err >4
( 3 ) NOOP >4 #err >4 +exp >3? #err >4 #err >4 ;

Listing Eighteen

4 WIDE FSM: <Fixed.Pt#>
\ input: | other? | num? | minus? | dp? |
\ state: ..............................................................
( 0 ) | DROP | >0 | EMIT | >1 | EMIT | >1 | EMIT | >2
( 1 ) | DROP | >1 | EMIT | >1 | DROP | >1 | EMIT | >2
( 2 ) | DROP | >2 | EMIT | >2 | DROP | >2 | DROP | >2 ;FSM

: state< ' >BODY LITERAL ; IMMEDIATE
: Getafix 0 state< <Fixed.Pt#> !
BEGIN KEY DUP 13 <> WHILE
DUP cat->col# <Fixed.pt#> REPEAT ;
Writing for Forth Dimensions

I once received an author's manual from another technical magazine. It was 26 pages of intimidating restrictions, rules, and regulations. You got the impression that, even if you managed to learn and obey all those constraints, the editors would be doing you a big favor if they deigned to publish your work.

Our guidelines, by contrast, are meant to encourage you. They are minimal, in order to accommodate different kinds of writing (scholarly/academic, anecdotal, philosophical, editorial, how-to, tutorial, etc.) and so as not to discourage anyone from sharing their Forth knowledge and experience.

Being published in the most widely read Forth periodical brings both personal and professional benefits. And the Forth community's vitality springs from good ideas, well communicated, circulating through many interesting and informed minds. We encourage you to write, and we hope that, like our other authors, you will be pleased when your article appears and will want to write often.

If you have an idea but aren't sure if it would make an appropriate article, or if you have any other questions, please feel free to contact me. It will be my pleasure to assist.

—Marlin Ouverson, Editor
editor@forth.org
c/o Forth Dimensions
100 Dolores Street, Suite 183
Carmel, California 93923 USA

What Makes a Good FD Article

We'd like to hear your suggestions. If you feel a subject is important, interesting, befuddling, or helpful, chances are good that many of your fellow readers of FD will agree. Here are just a few ideas from our list of editorial wishes:

• Tutorials about fundamental Forth techniques like factoring, minimizing stack juggling, and readability.
• Description of interesting details of ANS Forth that differ from previous practice.
• Application stories that show Forth in action. Describe the challenges, tell how you arrived at a solution, and share the final results.
• Classical programming problems demonstrated in Forth (e.g., sorts, filters, date routines) and efficient Forth versions of useful features found in other languages (e.g., strings à la Snobol, grep from C).
• Human-interest profiles of successful Forth vendors, corporate users, implementors, and innovators.
• Hardware-related pieces about, for example, Forth chips, embedded systems, robotics, and data acquisition. Such articles are most useful if they include "how-to" info.
• Experimental work that charts new directions for Forth or that addresses perceived deficiencies.
• Work that consolidates previously published material or that builds on or substantially improves earlier articles.
• Ways to improve Forth's visibility and acceptance.
• Academic papers, including Computer Science perspectives, are welcome although FD is not formally refereed.

Tips for New Writers — and getting rid of "blocks"

Every writer in an individual, so what encourages one may inhibit another. But if you can't seem to get started—or to finish—one of these ideas might help.

• Plan your article. Try top-down design and bottom-up writing: Start with your subject, make an outline, and check the logical flow of the information. Write the sub-sections, then work on smooth transitions between them. Add a motivational introduction and overview, then write a conclusion with observations, suggestions, and a summary.
• Thinking too critically or analytically while writing can dry you up. If this happens, just relax and jot down all your important points without regard for logic, format, spelling, etc. This is the brain-dump phase, and no one but you will see it. Later, simply rewrite and organize for clarity, focus, conciseness, organization, and completeness.
• Challenge the reader. When you take a stand or issue a challenge, readers tend to get involved, thinking and acting on their own—a worthy goal of many writers. So provoke readers to improve upon or extend your work, and to test it in their own environments; and encourage them to report their findings to FD in an article or letter to the editor.
• Have a beta test. Ask a friend or co-worker to read your article, or present it at a local FIG Chapter meeting to see if it communicates as well as you hope and to elicit useful feedback. Accept advice that makes your code or technique or article better (and tactfully ignore the rest).
• Ask for help. Often there are people at work, at the local FIG Chapter, or on-line Forth venues who are happy to critique your ideas or even to co-author an article.
• Finally, learn when to let go. No one ever feels completely ready to deliver that code or manuscript. Like many an application program, an article is subject to endless revision, refinement, and improvement until it ships. If it communicates well enough, is complete enough, and is accurate, ship it and move on! (Continues on page 31.)
If, in a 16-bit Forth, you type:

```
1234567890  <cr>
```

the system responds:

```
722  OK
```

Often, it's not OK. Many will remember that a patient was killed when an X-ray treatment machine delivered a massive overdose. The operator's display had shown the proper dose but, because of attempted corrections to the input, the displayed number was not the internally active number. Ever since I read that report, I have made sure that such an error could never occur in any of my programs. On a CRT with addressable cursor, I erase and rewrite the entire number after each change.

I am now designing a system that uses a 20-key keypad and an LCD display as the operator interface. It is built around an NMY-0020 board from New Micros Inc., and its 68HC11 processor has a MAXforth kernel in ROM. The keypad and display are standard devices, and the board has built-in interfaces to them.

My intention is that one or the other of these checks ... suffices to guarantee a number on the stack that matches the number on the display.

Keypad code supplied by New Micros uses a table-driven translator to map the keys to ASCII. By switching two pairs of wires, I am able to read the keypad directly as numbers, simplifying some of my code. The keys are labeled 0–F, and four blank keys with removable transparent covers are easy to label as desired. The keys, together with the interface, produce hex codes 0–13; with my alteration, they mean what they say. Codes 10–13 are minus, clear, backspace, and end.

The display I use is a passive liquid crystal display, but lighted LCDs and plasma displays that have the same pinout and respond to the same command set are available. The displays accept ASCII characters, have addressable cursors, and can report cursor position and the character at the cursor. They also have enough RAM so that eight characters can be defined by the program. (I can have a °, the degree symbol—nice!)

The code in the listings doesn't erase and rewrite after every change. Rather, the number is built on the display, and is read from the display when the operator presses End. The application must address the cursor to the part of the display where the number is to appear before using Lcd# to build the number. Lcd# expects TOS to be a number that sets the maximum number of digits, and leaves with a validity flag in TOS, and the number itself below it. It works in any base from binary to hex, and accepts only keys that have meaning in the current base. Lcd# won’t accept more digits than specified, but a minus sign (accepted only as the first character) doesn’t count as a digit.

Lcd# can handle 16-bit numbers. The validity flag doesn’t check all possible errors. Because the checks appropriate to signed and unsigned numbers differ, and Lcd# can input either, either a final check must be made by the calling application, or the code must be further specialized. The variable invert# contains the intended sign of the returned number. It has meaning until another number is built. For unsigned numbers, it must be zero (or the user entered a minus sign— you can check); and for signed numbers, it must agree with the actual sign of the returned number. My intention is that one or the other of these checks, combined with the validity flag, suffices to guarantee a number on the stack that matches the number on the display.

There is a way to get a wrong input, but it is easily avoided. The cursor will wrap from the end of the display back to the beginning, but not the other way. An attempt to build a number in a place where it can wrap around the end must be avoided. I can fix the code, but why?

There are many people I must thank for the help they provided in making this code better than I could have made it on my own: Rob Chapman, for the insights he provided into MAXforth; the people at NMI, who produced my nifty little system, supplied it with sample code, and made it a joy to use; and the many participants at comp.lang.forth from whom I learned much simply by reading their posts to others, and who always answered my how-do-I questions.

Additional code

The author can share “a little more code” that might be of interest to someone who wants to put messages on a display (e.g., Lcd-type); contact him via e-mail.

Jerry Avins • Kendall Park, New Jersey
jyavins@erols.com

The author held positions at RCA Laboratories’ David Sarnoff Research Center, New Brunswick Scientific, and others before retiring in 1987.
( Listing Zero: words needed to load the rest

: \ 0 WORD DROP ; IMMEDIATE \ Skip-rest-of-line word. (I like to have two.)

: WITHIN ( n lo-limit hi-limit+1 -- ?) OVER ->R ->R U< ;

\ Listing One

BASE 8 HEX

\ Support for 2 line by 40 character display. Thanks with nod to NMI JYA 2aug98

B080 CONSTANT lcd-cmd B081 CONSTANT lcd-data

\ Wait until the LCD isn't busy. (This can hang. Multitasking is better.)
: lcd-wait ( -- ) BEGIN lcd-cmd C@ 80 AND 0= UNTIL ;

\ Send command or data to LCD.
: lcd-cmd! ( C -- ) lcd-wait lcd-cmd C! ;
: lcd-emit ( C -- ) lcd-wait lcd-data C! ; \ LCD analog of EMIT

\ Make specific LCD command words.
: lcd-make ( c -- ) CREATE , DOES> ( -- ) @ lcd-cmd! ;

1 lcd-make lcd-clear 2 lcd-make lcd-home 8 lcd-make lcd-off
C lcd-make lcd-on ( On, no cursor ) 8 lcd-make lcd-cur ( On, with cursor )

: lcd-attr ( blink? cursor? display? -- ) \ Sets three display attributes
 0= 3 + 2* SWAP 0= 1+ OR 2* SWAP 0= 1+ OR lcd-cmd! ;

\ Initialize the LCD. Specific to a two-line by 40 display.
: lcd-init ( -- ) 01 OC 06 38 38 50 DO lcd-cmd! LOOP ;

\ The next 2 words translate cursor locations by number to and from LCD
\ data RAM addresses and add (on write) or strip (on read) the control bits.
\ They too are specific to a two-line by 40 display.

: lcd-at ( a -- ) 80 OR DUP A7 > IF 18 + THEN lcd-cmd! ; \ Write cursor addr
  ( Undocumented: FF lcd-cmd! resets the cursor, so BS doesn't need to check.)

: lcd-at? ( -- a ) lcd-cmd C@ DUP 27 > IF 18 - THEN ; \ Get current cursor.
\ This supposes that the display isn't reading GC RAM. The supposition is
\ true if cg-addr! hasn't been executed, or if lcd-at was executed after it.
\ (cg-addr! is used to generate special characters in character-generator RAM.\ That code isn't part of this listing.)

\ Carriage return, line feed, backspace, ->, and <-. All but BS and lcd- wrap.
: lcd-cr ( -- ) lcd-at? 28 / 28 * lcd-at ; \ Beginning of line
: lcd-lf ( -- ) lcd-at? DUP 27 > IF 28 - ELSE 28 + THEN lcd-at ; \ Other line
: lcd-bs ( -- ) lcd-at? 1- DUP lcd-at BL lcd-emit lcd-at ; \ Destructive BS
: lcd+ ( -- ) lcd-at? 1+ lcd-at ; \ Advances cursor position
: lcd- ( -- ) lcd-at? 1- lcd-at ; \ Backs cursor position

BASE !
Listing Two

Grayhill Keypad Series 86, marked 86JB2-202 G-97-059-J-9742 D$FPJ
Leads H <-> J and L <-> M are interchanged to simplify decoding.
NMI's Keypad.4th, modified. JYA; 7Aug98 Revised for F.D. 21Sep98

KEYPAD ROUTINES

BASE @ HEX

B00A CONSTANT keypad

\ True if a keypad key is pressed. Debouncing doesn't seem to be problem!
: ?keypad ( -- flag ) B000 C@ 1 AND ;

( Wait for keypad key to be released. This can hang at the user's whim!
: kp-release ( -- ) BEGIN ?keypad 0= UNTIL ;

\ wait for a keypad key
: get-key ( -- button )
BEGIN ?keypad UNTIL keypad C@ 2/ 2/ 2/ ;

: num->char ( n -- c ) DUP A < IF 30 ELSE 37 THEN + ;

\ Return the key number, wait for key release
: kp-key ( -- n ) get-key kp-release ; \ Keypad analog of KEY

\ NUMBER INPUT VIA keypad AND DISPLAY

( wait for a single digit. Reject any non-digit and continue waiting
( return the value of the digit 0 to BASE 1-
: lDIGIT ( -- n ) ( n -> LCD
BEGIN kp-key DUP BASE @ < NOT WHILE DROP REPEAT
DUP num->char lcd-emit ;

BASE !

Listing Three

A relatively foolproof way to read numbers with a keypad and alphanumeric
display. The number is first built on the display (in any base) and then
read back onto the data stack. TOS is validity flag which reports overflow
and catches non-numeric characters. The application can check two's-
complement wrap-around by comparing the sign of the result with the contents
of invert# before another number is built. When building the number, only
allowed keys are accepted. That is, only numeric keys are effective in base
10, the minus sign works only in the first position, and only as many
entries are accepted as the calling the argument specifies. (The editing
keys continue to work.) JYA 9Aug98 Revised for F.D. 21Sep98

BASE @ HEX
0 CONSTANT NO -1 CONSTANT YES
VARIABLE invert# VARIABLE #symbols VARIABLE valid#
: new# ( -- ) NO invert# ! 0 #symbols ! YES valid# ! ;
: good-key ( n -- n ? ) \ Flag is false if key need not be dealt with
DUP 2DUP ( n n n n )
10 > SWAP ( n n ? n )
BASE @ < OR SWAP ( n ? n )
10 = #symbols @ 0= AND
invert# @ 0= AND OR ; ( n ? )
: lsymbol ( -- n ) ( 10 through 13: -, ESC, BS, enter )
BEGIN kp-key good-key NOT WHILE DROP REPEAT ;

: key-bs ( -- ) \ Remove the last entry
#symbols @ IF
    lcd-bs #symbols l-!
ELSE
    invert# @ IF
        lcd-bs NO invert# !
    THEN
THEN ;

: restart# ( -- ) \ Remove all entries
#symbols @ invert# @ + ?DUP IF
    0 DO lcd-bs LOOP
THEN new# ;

: char->num ( c -- n )
DUP DUP 3A 41 WITHIN SWAP 30 < OR IF NO valid# ! THEN
    DUP 39 > IF 37 ELSE 30 THEN - ;

: build# ( n_max -- n_actual ) new# lcd-cur \ n is the number of digits.
BEGIN lsymbol DUP 13 = NOT WHILE
    DUP 10 = IF invert# 1+! 2D lcd-emit THEN
    DUP 11 = IF restart# THEN
    DUP 12 = IF key-bs THEN
    OVER #symbols @ > OVER 10 < AND IF
        #symbols 1+! num->char lcd-emit ELSE DROP
    THEN
REPEAT 2DROP #symbols @ ;

: read# ( n_actual -- result valid_flag ) \ lcd-on
0 SWAP DUP IF
    DUP lcd-at? SWAP - lcd-at
    0 DO BASE @ UM* lcd-data C@ char->num DUP
    BASE @ < NOT IF NO valid# ! THEN
    0 D+ IF NO valid# ! THEN LOOP
    invert# @ IF NEGATE THEN
    ELSE NO valid# ! DROP
    THEN valid# @ ;

: Lcd# ( n_max -- value valid_flag ) build# read# ;
BASE !
EXPRESS Factory Control

EXPRESS is a programming and operating system for the IBM type of computer, especially suitable for running machinery or running a factory. Years of development by FORTH, Inc. have made it competitive with programs written by large programming companies. Its particular specialty is real-time performance—more difficult than one would think but, of course, well-suited to Forth. An electrician testing my system pressed the switches on my simulator to see how fast the software would follow, pronouncing it successful in contrast to other systems he had seen. An industrial program requires industrial prices to keep it supported, so you won't see EXPRESS in a hobby environment.

My system took four years to develop and is 4.2 Megabytes of compiled Forth, large by EXPRESS standards. It runs almost all of four lime kilns, rock and lime distribution, and a crusher having nothing to do with the rest of the lime plant. Local control is effected with locally placed General Electric Programmable Logic Controllers (PLCs) distributed at the various use sites. A Stargate computer card from FORTH, Inc. provides eight RS-232 ports with eight individual small programs communicating with those ports. The PLCs are used mostly as dumb I/O terminals with the following exceptions: The more-distant PLCs and the complicated ones have a PLC program that toggles a bit back and forth at about 1/2 Hz.

The superintendent told me to not listen to the workers, so I went out of my way to hear what they had to say...

said bit to be read by EXPRESS. Another toggling bit is established at the EXPRESS end for each PLC. If either end or both ends fail to receive the other's toggling bit for five seconds, the PLC shuts down the chosen machinery outputs for safety purposes. If shutdown happens, the operator must re-establish kiln rotation, by computer or other means, or the lime kiln will be damaged. In real life, most of these errors have taken place by software blunders, especially by yours truly, but we rapidly get the plant operating again without harm. By "we," I mean myself and the electrician assigned to help me. I am not allowed to tamper with software alone while on site.

To help writing the new program, FORTH, Inc. provides an already known good program. MIXER.SRC illustrates good programming techniques, which one can then modify to accomplish the new goal. (FORTH, Inc. also provides training classes to help the starting programmer.)

The way I actually started was to program a minimalist belt system to distribute limestone. The virtues of this approach were that I could practice writing and could introduce the workers to a simple system in order not to overwhelm them. It is important to consider workers' fear, and one should not discount it. At a lime plant hundreds of miles away, the prospect of facing a new, full-blown, running computer system with minimal training was so daunting that several men resigned their jobs. Why? If you wreck a $10,000,000 lime kiln, management will look at you real funny for a long time.

Starting on my end with a simple stone belt distribution system, I drew a screen background with PC Paintbrush in 16 colors. One calls this background into place with the EXPRESS screen editor and then uses other EXPRESS software to lay icons and pushbuttons on this screen. I had a hard time starting up programming and made numerous phone calls to Dennis Ruffer, the main EXPRESS wizard at that time. My main difficulty lay in doing all the steps to make one pushbutton or one digital icon. I have since written my own instructions for doing this.

After getting this program working, we redid it in light of the worker' experiences. The superintendent told me to not listen to the workers, so I went out of my way to hear what they had to say; I mostly got away with implementing their desires. I quickly changed the meaning of the color icons. Now, green is only used for an electric motor running; stopped is gray or dark gray. Red is never used for stop, it means danger, instead. Dark green means that switches are set okay; the opposite is gray, dark gray, or red for tripped fuse. Dark red means a minor danger. This is in contrast to their hard-wired electrical panels, where green may mean a motor is running, but red may mean the same.

In contrast to establishing the icons, programming the logical operations in the PROCESs wasn't so hard. EXPRESS uses a partial infix notation to make the instructions English-like. Also, they have set up the logic as a state machine, which was a new form of logic to me. The idea of a state machine is that if you use a statement to turn an output on, you have to use another statement(s) to turn it off, rather than relying on the negation of the original statement. For example, see Listing One.

In this state machine, the first statement will turn cs2-LI on forever without the second statement. It requires the second statement or equivalent statements to provide for turning off cs2-LI. The state machine does not scan through the list of rules over and over again like the PLC logic does, for example. The state machine remains idle until an event occurs. In this example, the event is the turning on or turning off of cs2-au or cs2-ov. Then it will scan the list of rules...
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FORTH DIMENSIONS BACK VOLUMES

A volume consists of the six issues from the volume year (May–April).

Introduction to FIG, threaded code, TO variables, FIG-Forth.

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Generic sort, Forth spreadsheet, control structures, pseudo-interrupts, number editing, Atari Forth, pretty printing, code modules, universal stack word, polynomial evaluation, F83 strings.

Volume 8 Forth Dimensions (1986–87) 108 – $35
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FORML CONFERENCE PROCEEDINGS

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Rockwell Forth processor, virtual execution, 32-bit Forth, only for vocabularies, non-IMMEDIATE looping words, number-input wordset, I/O vectoring, recursive data structures, programmable-logic compiler. 295 pp.

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BOOKS ABOUT FORTH

ALL ABOUT FORTH, 3rd ed., June 1990, Glen B. Haydon $201 – $90
Annotated glossary of most Forth words in common use, including Forth-79, Forth-83, F-PC, MVP-Forth, Implementation examples in high-level Forth and/or 68068/68 assembler. Useful commentary given for each entry. 504 pp.

eFORTH IMPLEMENTATION GUIDE, C.H. Ting $215 – $25
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Embedded Controller FORTH, 8051, William H. Payne $216 – $76
Describes the implementation of an 8051 version of Forth. More than half of this book is composed of source listings (w/disk) 511 pp.

F83 SOURCE, Henry Laxen & Michael Perry $217 – $20
A complete listing of F83, including source and shadow screens. Includes introduction on getting started. 208 pp.

F-PC USERS MANUAL (2nd ed., V3.5) $350 – $20
Users manual to the public-domain Forth system optimized for IBM PC/XT/AT computers. A fat, fast system with many tools. 143 pp.

F-PC TECHNICAL REFERENCE MANUAL $351 – $30
A must if you need to know F-PC's inner workings. 269 pp.

THE FIRST COURSE, C.H. Ting $223 – $25
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THE FORTH COURSE, Richard E. Haskell $225 – $25
This set of 11 lessons is designed to make it easy for you to learn Forth. The material was developed over several years of teaching Forth as part of a senior/graduate course in the design of embedded software computers systems at Oakland University in Rochester, Michigan. 156 pp. (w/disk)

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Listing One

If cs2-av is on and cs2-ov is on then on to cs2-L1;
If cs2-av is off or cs2-ov is off then off to cs2-L1;

Listing Two

If cf2-bu is on then off to cf2-bu
   if cf2-bu is on and cf2-ru is on then off to cf2-ru end
   if cf2-OM is off and cf2-bu is on
      and cm2-ru is on then on to cf2-ru end;

Listing Three

if ... then ... endif \ endif: go to following
if ... then ... else ... endif \ instruction.
if ... then ... end \ end: jump to
if ... then ... else ... end \ end of the word;

Listing Four

PROCESS Example
   BOSS Boss
   MODE State
   \ one may define I/O here
   \ one may perform logical operations on the I/O
   If Boss commands start then on to State
   If Boss commands reset then off to State
      \ 'commands' is synonym for 'is'
   END-PROCESS

Listing Five

\ Process Example, here I/O detects a fault, so communicate
... fault to Boss ; \ same to superior.

Listing Six

\ Process Master
If Xexample is fault then ... \ operate warning system.

until all updates have been made, then will remain idle. Not
all things are events. A variable known as an INTEGER is not
an event, and so cannot be placed before the then because
the rule would not fire properly.

FORTH, Inc. has expanded the above structure for more
elaborate programming. Consider the rule in Listing Two,
taken from an actual program.

The only event required above is cf2-bu being on. In the
sub-rules, starting with if, the situations coded are not required
to be events; this is especially good for analog situations which
are not events. Thus, non-event logic can be written as shown
in Listing Three.

A few in the Forth community have found the partial in-
fix notation to be uncomfortable, but I can see its point and
I feel at home with it now.

The unit of programming in EXPRESS is the PROCESS. The
absolute minimum PROCESS is given in Listing Four.

I have all my processes Reporting to the PROCESS Master
which must be the head process. FORTH, Inc. has complained
that my processes are too few and too big compared with the
best programming style, which would in-
clude subordinate processes of processes.
Processes are intended to be independent
and to have minimal communication with
each other for good programming strategy.
Since this is FORTH, one can force commu-
nication between independent processes with
the TASK command but I use it sparingly,
trying to keep good programming practice.

For processes that depend on each other,
the usual way to send information between
them is to define the communication dic-
tionary APPLICATION-MESSAGES and fill it
with whatever words one wants to mention,
like fault. The word really has no mean-
ing as we think of it. To the computer, it's
just an index number in the dictionary. The
subordinate Example will say, as in a logi-
cal output statement... [...see Listing Five].

Then one catches this pseudo-command
in Master and says something like Listing Six.

Recall that this is a state machine and
one must turn all these "commands" off
with separate instructions, or else they stay
stuck on. Also, I found out that if I invoked
rapid-fire logical situations to the Boss from
the same subordinate process, the Boss
couldn't be relied upon to keep things
straight. So I simplified the system by mostly
exchanging warning system messages,
which are less frequent.

While I programmed the General Elec-
tric ladder diagram logic, I was always counting the limited
number of timers to be sure I wouldn't run out. With EX-
PRESS, I have an abundance of these resources, a great conve-
nience.

The biggest advantage is the Forth ability to change the
entire system if one wants to. When I first got the system,
I made a wish list of how I would like things to be: (a) multiple
color icons rather than two colors, (b) choice of decimal-point
position in analog readouts, (c) better scales for historical
trends, etc. Over the years, I got these features (and so did
other EXPRESS programmers) by getting my company to pay
a modest fee to FORTH, Inc., and then waiting a week or two
for the programming. Changes to non-FORTH languages cost
ten times more and take a year to accomplish, assuming one
can get the vendor to agree to change.

Competition is stiff from other companies, but EXPRESS
has true real-time interactive control, which most competi-
tion cannot manage. It certainly has worked out well for our
application for effective factory control.
NEW and OLD Lines

Here is a convenient method for managing two versions of a source file. This may be an existing version and a revision, standard code and a more efficient environmentally dependent version, code you've acquired and your changes to it, etc.

Instead of eliminating or commenting out old lines, prefix them with [O] and a space. Prefix your new lines with [N] and a space.

The [N]-lines will be processed and the [O]-lines ignored.

To revert to the old lines in whole or in part, do Reversion ON before processing old and new lines. Reversion OFF turns that off.

To convert to the new form, use an editor to discard [N] and lines prefixed with [O].

1 VARIABLE Reversion ( `Reversion ON` for old lines. )
3 : [N] Reversion @ IF POSTPONE \ THEN ; IMMEDIATE
5 : [O] Reversion @ 0= IF POSTPONE \ THEN ; IMMEDIATE

Special Characters in Strings

S" ccc" gives us a string literal. But a " can’t be in that string. Neither can control characters.

For this purpose, the Tool Belt has S. Like other functions in the Tool Belt, S takes the first character of the next word as a delimiter.

S | Just say "No". | TYPE

S also uses ^ before the 32 characters beginning at $ to yield control characters 0 through 31. ^? yields 127.

S " Just say "M"J"I"NO"M"J" puts a CRLF (carriage return and linefeed) and two tabs before NO, and CRLF after.

If ccc does not contain a " or ^ then S " ccc" is equivalent to S" ccc".

7 : ?maximum ( n max -- n ) OVER < ABORT" Maximum SizeExceeded " ;
9 ( `str len caddr >control>` copies a string from str len
to caddr, converting characters after ^ to control characters.
11 ( It returns caddr and the converted length. )
13 : >control> ( str len caddr -- caddr k )
14 0 2>R ( R: caddr k)
15 BEGIN DUP WHILE ( str+i len-i)
16 OVER C@ [ CHAR ] ^ CASE? IF
The following implements the function of local variables with two pre-named variables.

2VARIABLE TEMP
MACRO PUSH " DUP @ >R ! "
MACRO POP " R> SWAP ! "
MACRO 2PUSH " DUP 2@ 2>R 2! "
MACRO 2POP " 2R> ROT 2! "

At the beginning of your definition: value TEMP PUSH.
At the end: TEMP POP.

Or, at the beginning of your definition:
value' value TEMP 2PUSH.
value' is in TEMP CELL+.
At the end: TEMP 2POP.

Within your definition you can use TEMP and TEMP CELL+.
This recovers and improves the old use of I and I'. The values in TEMP and TEMP CELL+ are available in called definitions.
Character Tests

In the preceding installment of "Stretching Forth," functions to test characters were given.

\begin{verbatim}
isalnum  isalpha  iscntrl  isdigit  isgraph
islower  isprint  isspace  isupper  isxdigit
\end{verbatim}

In this episode, more functions are given, especially to test characters in a string.

In 1982, Klaus Schlesieck introduced \texttt{SKIP} and \texttt{SCAN}. They were employed in the Laxen-Perry F83. I used them and \texttt{-TRAILING} happily for many years.

However, they are not powerful enough to handle the text I want to massage today. In particular, they consider only a single character at a time, and do not handle a space character as Standard Forth requires.

Take \texttt{-TRAILING}. It scans a string from back to front looking for a non-blank. This was fine when source and text were on blocks, but today I want to skip back across control characters as well.

First, let’s factor the backward scan process into two parts.

\begin{verbatim}
1 MACRO BACK1 " BEGIN DUP O> WHILE 1- 2DUP CHAR$ + C@ "
2 MACRO BACK " 0= UNTIL 1+ THEN "
\end{verbatim}

The traditional \texttt{-TRAILING} can be defined:

\begin{verbatim}
: -TRAILING ( str len -- str len-i ) BACK1 BL= BACK
\end{verbatim}

Now let’s define a modern version of \texttt{-TRAILING} that will back over blanks and control characters.

\begin{verbatim}
4 : BL? ( char -- flag ) [ CHAR$ ] ! - 94 U< NOT ;
6 : TRIM ( str len -- str len-i ) BACK1 BL? BACK
\end{verbatim}

\texttt{BL?} is used to identify characters that match a blank in Standard Forth parsing.

\texttt{TRIM} was adopted from Snobol. First I updated \texttt{-TRAILING} but there are uses of \texttt{-TRAILING} surviving that need the original definition.

\texttt{SKIP} has also been replaced with a pair of macros.

\begin{verbatim}
8 MACRO SKIP " BEGIN DUP WHILE OVER C@ "
9 MACRO |SKIP " WHILE 1 /STRING REPEAT THEN "
\end{verbatim}

Definitions of \texttt{SKIP} and \texttt{SCAN} can be written.
Balancing TRIM, we often want to skip past blankish characters.

To parse strings from a longer string, use SPLIT ...

The function works by compiling the string into a bitmap. Individual characters or ranges of characters may be given. Control characters can be given by the `X convention.

As a character -- must be first or last, ^ must be last. -- and ^ may end an x-y range. Control characters ^X may not be in ranges.

In the compilation, set-char-match converts from a character string to the bitmap. It goes across the string given in the source, character by character, treating each as a control character, range, or single character. Special tests are made on the first and last characters. set-bit takes a character as a bit offset, and the working bitmap, and sets the appropriate bit in the bitmap.

addr&mask converts a bit offset and a bitmap to an address and mask.

bit&byte takes a bit offset and converts it to a bit and byte offset.

get-bit-as-flag is used to get the result. It takes a character as a bit offset, a bitmap, and the length of the bitmap (which it discards), and returns true when the appropriate bit in the bitmap is set.

SLITERAL compiles the bitmap.
Here is how the Standard character test functions might have been written.

: isupper [ ANY ] " A-Z" ;
: islower [ ANY ] " a-z" ;
: isalpha [ ANY ] " A-Za-z" ;
: isalnum [ ANY ] " A-Za-z0-9" ;
: isdigit [ ANY ] " 0-9" ;
: isxdigit [ ANY ] " 0-9A-Fa-f" ;
: isgraph [ ANY ] " !-~" ;
: isprint [ ANY ] " --" ;
: isctrl [ ANY ] " --" NOT ;
: isspace [ ANY ] " ^I^J^K^L^M" ;
I hate making out tax forms (who doesn’t?). When I was still doing my own a few years ago, I decided to ease the sting a bit by combining the task with something I really liked to do—programming Forth. I am showing you what I did as an example of simple system design for a specific purpose. Note! The actual code shown here conforms to the U.S. tax code as it was thirteen years ago. There have been numerous changes since, so this code cannot be used “as is” to figure your 1999 taxes!

The actual task of developing the system was really one of translation, because the 1040 tax booklet is already a program with a few peculiarities. It is written in English (sort of!) and designed to be executed by humans. Like any program, the goal is to be complete, unambiguous, and correct. All I had to do was select the portions relevant to my situation and translate them into Forth.

Form 1040 can be looked at as a top-down design, a tree structure of calculations and sub-calculations (“Dividends (attach schedule B if over $400)... subtract line 9b from line 9a and enter the result...” etc., etc.). A little thrashing around established a good general pattern for a Forth-based approach:

Rule 1: Use a separate Forth word for each calculation step.
Rule 2: All words take zero arguments and leave one double-precision value on the stack.

This combination made it easy to extend the calculations as necessary in a top-down design (implemented bottom-up, of course). As usual in Forth-based U.S. financial calculations on 16-bit systems, all amounts are in cents and in double-precision integers when the number has a decimal point, but its position is ignored, so results will be expressed as an integer number of cents. This is an environmental dependency.

Then we have:

| `: CITE.DEDUCTIONS ( --- d1) \ Total city income deductions 600.00 DROP EXEMPTIONS UM* ;` |
| `: CITE.TAX ( --- d1) \ City income tax GAIL.W2.WAGES CITY.DEDUCTIONS D- 15 1000 M*/ ;` |

The city tax rate for non-residents was 1.5% after deductions. For the feds, the hierarchy works this way:

```
:TAXES.DUE ( --- d1) INCOME.TAX WITHHOLDING D- ;
:WITHHOLDING ( --- d1) 9927.57 3153.05 D+ ;
:INCOME.TAX ( --- d1) TAXABLE.INCOME 47670.00 D- 38 100 M*/ 10171.60 D+ ;
```

This is the Forth translation of “tax owed is $10,171.60 plus 38% of the amount over 47670.” As an example of breaking things down as far as we need to, but not farther, let’s look at:

```
:DEDUCTIONS ( --- d1) TAXES INTEREST D+ CHARITY D+ MISC D+ ;
:MISC ( --- d1) DUES BOOKS D+ CONFERENCES D+ ;
: DUES ( --- d1) 144.00 (NASW)
15.00 (SEMCO) D+ 56.00 (AIAA) D+
96.00 (ESD) D+ 56.00 (ASA) D+
50.00 (TIMS) D+ 20.00 (FIG) D+ ;
```

Here we have an improvement on an adding machine tape; all the amounts are commented to identify them, they are aligned in columns for easy reading when the screen is printed, and if necessary they can be corrected or extended by editing.

That should be enough to give a flavor of the process. The full system is just more of the same, tailored to the specific calculations needed. Each line on the tax form can be arrived at by typing the appropriate word followed by $. My estimate is that it took a little longer than it would have by hand. On the other hand there was the personal pleasure of expressing it in code, and the opportunity to correct mistakes or add last-minute items without having to re-do everything. Finally, by printing ten screens, I had a permanent record of exactly how I had done all the calculations. QED (quite easily done). The whole thing is only ten screens, because I only had to code for my taxes, not those of the whole world. This brings home Chuck Moore’s wisdom when he recommends avoiding over-generalization.
Getting There

This year, my son Jason and myself were to be traveling companions. Jason is a fairly typical seven year old, with definite likes and dislikes. Introducing him to new food ideas was going to be an interesting challenge. We flew from Bristol Lulsgate Airport on the first leg of our Journey, Brussels and the delights of Belgium. The idea was to look up a few friends from my time at Europay and to do a bit of sightseeing (mainly Brussels and Waterloo).

During our few (albeit wet and windy) days, we managed to see the attractions of the Atomium (a very large model of an iron atom), Autoworld (a historical car museum), the squares and statues of Brussels (including its most famous, The Mannekin Pis). In Waterloo, or rather more south near Braine L'Allieu, we steeped ourselves in the history of 1815—the Battle of Waterloo.

On the Thursday, we left Waterloo for Brussels and thence to Luxembourg. I had planned a stop-over for few hours as a break from a train journey of over six hours. We walked round for a while then spotted a touring Dotto which had a recorded presentation explaining the history of Luxembourg (well worth the fare if you only have a short while). It seems that Luxembourg was built up and destroyed several times over during its more than 1000 year history.

Finally, we boarded our next train, for Trier, getting into a discussion on programming with two Spaniards and an Englishman. Naturally, yours truly espoused the benefits of programming in Forth. At Trier, just time for a quick refreshment then on to Saarbrucken by the next train. At Saarbrucken, we took the train to Turkismuhle (which turned out to be two, with a change at Saint Wendell) and then a taxi to Schloss Dagstuhl (near Wadern).

The Venue — Schloss Dagstuhl

Schloss Dagstuhl, or Dagstuhl manor house, was built in 1760 by the then-reigning prince Count Anton von Öttingen-Soetern-Hohenbalder. After the French Revolution and occupation by the French in 1794, Dagstuhl was temporarily in the possession of a Lorraine ironworks. In 1806, the manor house, along with the accompanying lands, was purchased by the French Baron Wilhelm de Lasalle von Louisenthal. In 1959, the House of Lasalle von Louisenthal died out, at which time the manor house was taken over by an order of Franciscan nuns, who set up an old-age home there. In 1989, the Saarland government purchased the manor house for the purpose of setting up the International Conference and Research Center for Computer Science. The first seminar in Dagstuhl took place in August of 1990. Every year, approximately 2,000 research scientists from all over the world attend the 30–35 Dagstuhl Seminars and an equal number of other events hosted at the center.

Internationalisation Workshop

The Internationalisation (i18n) Workshop preceded the main conference, occupying the Friday morning. The need for this was the result of the ANS to ISO Fast-Track vote when the European Forth Community declared a need for internationalisation (i18n) issues to be considered in the amendments to the ANS document. i18n issues cover not only language and cultural aspects, but also time and date formatting. There was a concern that any effort in i18n should not break existing code. This ruled out changing the characters-access words C®, C!, CMOVE, and COUNT. This led to the proposal that a new Internationalisation Wordset be created. Some of the discussion related to the adequacy or otherwise of UNICODE characters. Whilst it is true that the most commercially significant languages are catered for, there are still a number of languages and character sets that are not. Many of these are variable-length characters. The workshop ended by agreeing on the basic wording of a proposal to the ANS Technical Committee.

There is an Internet mailing list which is in operation to continue discussion of the specific proposals, and anyone who needs to make their views known on this issue should join the discussion. This is run by Anton Ertl and you can subscribe by sending e-mail to:
anton@mps.complang.tuwein.ac.at

The Conference

The conference proper began in the afternoon. The first session was on “Forth Philosophy and Standardisation" and was kicked off with a paper by M.L. GASSANENKO but presented by SERGEI BARANOV. Russia and its economic problems meant that Sergei’s ticket had to be organised from outside Russia, leaving Sergei to represent Russia in its entirety (or as much as he was able). The subject of the first paper was “Context-Oriented Programming.”

EGMONT WOITZEL then gave us “Transient Scope, Word Lists and Language Construction.” This compared the state-driven method and prefix-driven methods. In the state-driven method, the search order is made implicit by state transitions. In prefix-driven methods, there needs to be a consideration of the search order as it is effected by the modularity strategy, parse strategy, and the transient scope strategy. The paper identified the need for improvements in interface and naming conventions and source code management. Header suppression was seen as a complicating factor for maintenance and debugging. The audience felt that this was more about scoping control for personal use rather than wider area of usage.

PETER KNAGGS then took the floor to explain the structure and form of the continuing ANS (and subsequently ISO) standardisation efforts. It seems that Forth was the first “ex-
"Extensible" language to be standardised. He briefly covered Forth's problem (extensibility) and a solution to gaining standardisation via an open pre-standardisation review. This revolved around gaining a wide review audience for new words and wordlists proposed for standardisation. There is, therefore, a new procedure proposed which is under consideration by the TC.

Peter went on to inform us about the changes in ANS committee structures. The ANS Technical Committees are now IT1 Technical Committees (even though the standards publications remain ANS). NCITS (which was the X3 secretariat) now incorporates J14 (the Forth Sub-Committee). The result of all this is that the committee has a new designation and is now known as NCITS/J14.

The first ANS standard was "fast-tracked" to an ISO standard, and ANS have the responsibility for its maintenance. However, when the ISO standard was issued, there was a proviso that the Internationalisation Issues be looked at for the next revision. The ANS standard is now up for revision, and the following changes are expected to be made:

a) All words marked as obsolescent in the current standard to be deleted.
b) Ratification of all clarifications issued in response to the nine requests already answered and the two requests that remain outstanding.
c) Support for embedded and ROMable systems.
d) Support for internationalisation and extended character sets.

Items c) and d) are, of course, both demands from the ISO fast-track process.

Updating the ANS standard is a two-year process.

Anyone can join the TC if they fulfill the membership criteria. This includes paying $300 per year and attending the first two meetings (in the USA) and two thirds of all meetings. You also have to vote in more than 80% of all letter (e-mail) ballots. Meetings are July and November.

The NCITS/J14 committee can set up task groups to look at specific items and produce a report. Membership to this is open to anyone for $300 per year (TC members get on for free).

Finally, it was proposed that a public notice board be established as part of the NCITS/J14 web site:

file://ftp.uu.net/vendor/minerva/uathena.htm

This would enable announcements and posting of the new proposed words and wordsets to be aired for comment.

Johnathon Morrish of Microm Engineering managed to do a paperless paper on the PIC entitled "Spiders and Forth." This featured the device in various sizes of configuration and packaging, and mentioned some real applications (including one involving "Cats-Eyes," the devices that divide the lanes on UK roads). Nick Nelson, of the same company, also did a paperless paper, "A Grid Control in Forth," which dealt with graphical objects in windows environments. Reuben Thomas expounded on "Mite: a Fast and Flexible Virtual Machine," while Sergei Baranof covered again for M.L. Gassanenko and presented "Open Interpreter: Portability of Return Stack Manipulations."

Within session four, on old and new words, Anton Ertl attacked state-smart words and proposed some interesting solutions, comparing various other system implementations in the process. We also had Michael Milendorf talking about the proper use of CATCH and THROW, and Manfred Mahlow and Klaus Schlesiek spoke about PRELUDE and FINALE, context-switching words which apply limited pre- and post-execution facilities.

The final session kicked off with the double act of Paul Bennett and Malcolm Biegler relating the experience gained in applying software certification to a Forth-based medical "life-support" product. The fact that such certification was considered late in the project and was completed in three weeks was partly due to the use of Forth and to the effort and dedication of Paul's team of code reviewers. The certification documentation was accepted by the notified body who were evaluating the product for CE marking under the Medical Devices Directive and further work towards FDA approval. The process did identify some serious flaws in the code which were put right by the authors prior to the CE marking evaluation, and it was recertified. Bernd Paysan presented another astounding demonstration of MINOS and the way 3-D graphics could be integrated. The final paper of the conference was presented by Stephen Pelc, who presented a "Portable Forth Optimising Native Code Compiler."

The Conference Circuit

EuroForth is settling down to a three-year cycle. The cycle has a year in the UK (various locations), a year in Germany (mostly at Schloss Dagstuhl), and a year in a guest country. As the 1997 conference was in Oxford, England, and this year was at Schloss Dagstuhl, next year is the turn of a guest country. St. Petersburg has been proposed for 1999, with Vienna in reserve. A final decision will be made in February 1999. This leads the venue back to the UK for the year 2000 and, as this is going to be a significant year for locations meridian, the organisers have decided to pursue the possibilities that might be afforded by Cambridge.

In conjunction with the above, it was also decided that a EuroForth mailing list be established to assist in the organisation (by e-mail) of future conferences and open discussion of conference topics. An announcement has been made in the newsgroups and by e-mail to this year's participants already. For others wishing to subscribe, an e-mail to euforth-subscribe@egroups.com will get you on. An archive of the mailing list will be available from:

http://www.egroups.com/lists/eurofouth/

All this is linked from Peter Knaggs' Forth pages at:

http://www.dec.bournemouth.ac.uk/Forth/

Impromptu Papers

Malcolm Biegler — "EPP, the forgotten standard," discussed probably the most useful port on the PC, the parallel port. Having presented a little history, Malcolm went on to espouse the merits of using the port. He also displayed some code for interfacing to the port in EPP mode.

Reuben Thomas — "Demi Doubles," a short exploration of double-cell values and words that utilise them.

Klaus Schlesiek — "Uses of other ASCII codes," really a request for opinions on the standard uses of some of the ASCII punctuations. He was looking for one or two characters for which there was not an already common usage.

Peter Knaggs — "Journal of Forth Application and Research (JFAR) Status." This report on the current status of the JFAR publication was an update of the report given at last year's conference. Peter has now managed to install himself in the
position of editor and has begun to publish accepted papers on the web. There are plans to print paper copies of the material when enough are collected to make it worthwhile, and to publish the collected papers on CD also. The back-issue paper publications will be fully indexed on-line and may also be included on CD when they are scanned in. The web sites are at:

http://dec.bournemouth.ac.uk/Forth/JFAR/ (main site)

http://www.jfar.org/ (mirror of main site)

PETER KNAGGS — “USA Conferences,” mainly a quick talk about The Washington Forth Party which was tentatively booked for the 23rd and 28th July in Washington DC.

HOWARD OAKFORD — “Angles, Trig and Complex Numbers,” mainly a plea for help. Howerd expounded the problems he was having considering the more complex maths involved in resolving trigonometric calculations from a complex number input. He felt that keeping the complexors as a pair of cells made sense until the last possible moment before usage. Several offers were made to share code with him.

The Conference Workshops

There were three workshop stream topics this year:

Methods and Objects

This workshop reported that there now seems to be a convergence of ideas and techniques amongst those who are interested in object-oriented wordsets. It seems like a bit more discussion and work may actually get a consensus on this subject. We may even be able to look forward to an OO wordset being proposed for consideration by NCITS/J14.

Project Management

This discussion centred on three aspects.

“Project Start,” which identified customers as belonging to two types: those with and those without a specification. This seemed to imply that each type would be best served by different system development models, these being “waterfall” and “spiral,” respectively. It was agreed that the waterfall model of development had been written up and explained often enough to be clear to everyone. However, there seemed to be scant information on the spiral model, and it was only alluded to in many reference books without being fully described in project terms.

For a spiral development model, it was agreed that risk assessment, awareness of the customer’s overall business goals, and early review of applicable standards and legislation. The client contact needs to be offered the means to “buy-in” to a proposal it to the rest of his company. It was also identified as important to do a “post-mortem” on each and every project to see if there are lessons to be learnt.

“Administration” identified a need for good support tools for version management, problem reporting and tracking and, in essence, good configuration management. Reviews were seen as necessary to ensure compliance of code to “house” coding and documentation styles, technical integrity of the product, and general quality. A reminder was issued that documentation errors are also bugs, and English documentation is needed with the code to explain the code to non-programmers who may be part of the review team.

“Group Working”—even in Forth, programmers are working in teams. This requires that projects be properly structured, in step with the structure of the product. This helps in team management and provides stronger componentisation.

Virtual Machines

Since Forth is frequently implemented using a virtual stack machine, the available implementation techniques have been studied in some detail over the years. This workshop showed, however, that a number of new questions are being raised in this area. These involve the deployment of Forth virtual machines in complex environments involving Windows and networking, and in particular we discussed issues raised by client-server programming.

“Implementation.” Could a stack-based virtual machine be a basis for just-in-time compilation? It was noted that advanced optimisation techniques for converting Forth into native code are being implemented in the latest MPE Forth compilers. Similar techniques could be used for JIT conversion from token or threaded code. Current work on both stack and register-based virtual machines was discussed. It was noted that Forth, unlike Java, retains a trap door to the underlying physical machine through the ability to add code definitions. This allows it to be tuned very effectively to particular applications.

“Functionality and Portability.” The virtual machine needs extending to provide access to GUI toolkits (e.g., TK) and communication technologies (e.g., TCP/IP) at an appropriate level of abstraction.

“Client-Server Deployment.” Forth will perform well in a client-server environment, particularly where extended functionality is required. Distributed functionality can be obtained by communicating Forth source text between nodes, possibly in tokenised form. Security issues need to be investigated.

The Competition

It has long been a tradition at Forth conferences to have a fun competition (which may or may not include coding). This year, it was decided that we should relate Forth to everyday life. The task was to write some code that must be:

a) Readable
b) Portable
c) Maintainable

d) Definitions for undefined words

The participants had to work with a well-known phrase containing three previously defined Forth words and three undefined words. The participants had to provide:

1) Name for the definition
2) Stack comment
3) A description
4) Definitions for undefined words

The well known phrase that was provided as a starter was SEX, DRUGS, ROCK AND ROLL.

As is usual with this kind of competition, extra points were obtainable for imaginative use of commas, and all attempts to influence the judges are, naturally, gratefully received.

Sadly, not many entries made it by the deadline. The entered codings were all highly amusing, despite some entrants displaying the fact that they had not fully understood the specifications. After due deliberation by the contest judging panel, PAUL BRUIN won through to receive the coveted “Fat Cigar” award, a prize deemed fitting the content of the competition.

One entry that arrived by e-mail, but which did not receive a prize, was from a Mr. W. Clinton, of Little Rock, Arkansas.
DEFER DRUGS \ n ----- ; context sensitive  
BILL'S_DRUGS \ n ----- ; attitude

INHALE? NOT ME! THROW

SEX \ --- u; none of your business

PRIVACY CONTEXT!
JOURNALIST @ EXECUTE
MONICA @

ROCK \ --- 
SHAKE RATTLE ROLL

I:\ LIFE \ attitude, -- report
IS DRUGS
BEGIN
SEX DRUGS ROCK AND
TERM TIME-OUT?
UNTIL
ROLL OVER

BILL'S_DRUGS LIFE

Though this was considered useable as a model, it had

Listing One -- the winning entry

1 CONSTANT XY \ Male object (constant is best used)
0 CONSTANT YY \ Female object (variable may be better)

WAY2LIVE ( no_fixed_address\XY\YY -- )
\ Forth proposal for a better ANS standard (of living)
\ Note: ANS = another non-standard standard
SEX, \ Having fun without spawning child processes
DRUGS, \ an unconventional (u141) technique
ROCK \ sorting and fine-tuning
AND \ consolidation of resources
ROLL \ prioritising your life
! \ and keeping the results

SEX ( nfa\XY\YY --nfa\XY )
\ Having fun without spawning child processes
2 PICK @ \ if there's anyone at home....
IF 1 PICK 0 \ we'll try and pick her up
?DO \ then check if she does!
OVER \ if successful, do it over..
OVER \ and over again (if possible)
+ \ add it all together
IF \ if we got a result
LEAVE \ ... we'll make a fast exit
THEN
LOOP
THEN
DROP \ if she's still around at this stage, we'll drop her

DRUGS, ( nfa\XY -- NFA\YX )
\ trying to scramble/unscramble the data
OVER >R \ hold on to the important stuff...
R@ ! \ before we change the current state
R@ W@ \ if we aren't completely fulfilled...
R@ 2+ W@ \ we should try all our options
SWAP \ now we must prioritise things.
R@ W! \ try to hide some stash here
R@ 2+ W! \ ..and hide the rest over here
R> @ \ finally, we try to find ourselves

ROCK ( nfa\YX -- nfa\XY\XY\X )
\ sort, stabilise and fine-tune the data
DRUGS, \ start off with some more of this
1 PICK \ now try some string manipulation (m12n)
OVER 4* \ use some clever cellular tricks
ERASE \ and prepare our bass (sorry, should be base)
DUP \ first make a back-up copy....
DUP \ before making a master copy

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some serious problems in the coding (obviously not tested). Another entry, which unfortunately arrived too late for inclusion, but which did work well, was by MALCOLM BUGLER. This entry is not included in this report but may be available for download from the EuroForth web-site with the electronic version of this report.

MICHAEL MILENDORF gave us:

```
HEX \ A hex value
 \ BABE hex value
 \ FACE hex value

: SEX ( -- ) RECURSIVE
 SEARCH A BABE
 FIND IF
   SEE FACE AND EVALUATE ,
   PICK BABE , EMIT WORDS ,
   DO ROCK AND ROLL LOOP ,
   DO DRUGS LOOP ,
   BEGIN
     FORGET WORDS
     MOVE AND ROLL WITHIN OPEN SPACE
     THROW
   UNTIL
   ELSE
   SEX
 THEN

: ROCK ( -- )
 BEGIN
   MOVE AND ROLL !
   DUMP AND THROW !
   DROP
 UNTIL
```

This, it was felt by the judges, had missed some of the essence of the competition rules. However, the winning entry presented in Listing One had more merit and was accepted in the obvious spirit of universal harmony that it displayed (or perhaps the author likes having sex with aliens). Obviously, you need to use the backwards loader to get this one into the computer, as it was written top-down fashion.

Other Prizes

Other prizes were awarded for the best papers and presentation, and a "best dressed for dinner" prize:

ANTON ERTL, for a paper displaying a most-incisive applicability.
PAUL BENNETT and MALCOLM BUGLER, for best real-life application of Forth.
JASON BENNETT, best dressed for dinner (stealing the title from Malcolm Bugler).

The Survivors Party

After dinner, Malcolm Bugler organised us into teams of four, passed round the words of a song and tasked us to perform it as a barbershop quartet. After a little practice, the teams gave their often-amusing renditions. There followed a few more impromptu songs and plenty more boozing.

Author Recognition Program

To recognize and reward authors of Forth-related articles, the Forth Interest Group (FIG) has adopted the following Author Recognition Program.

Articles

The author of any Forth-related article published in a periodical or in the proceedings of a non-Forth conference is awarded one year’s membership in the Forth Interest Group, subject to these conditions:

a. The membership awarded is for the membership year following the one during which the article was published.

b. Only one membership per person is awarded in any year, regardless of the number of articles the person published in that year.

c. The article’s length must be one page or more in the magazine in which it appeared.

d. The author must submit the printed article (photocopies are accepted) to the Forth Interest Group, including identification of the magazine and issue in which it appeared, within sixty days of publication. In return, the author will be sent a coupon good for the following year’s membership.

e. If the original article was published in a language other than English, the article must be accompanied by an English translation or summary.

Letters to the Editor

Letters to the editor are, in effect, short articles, and so deserve recognition. The author of a Forth-related letter to an editor published in any magazine except Forth Dimensions is awarded $10 credit toward FIG membership dues, subject to these conditions:

a. The credit applies only to membership dues for the membership year following the one in which the letter was published.

b. The maximum award in any year to one person will not exceed the full cost of the FIG membership dues for the following year.

c. The author must submit to the Forth Interest Group a photocopy of the printed letter, including identification of the magazine and issue in which it appeared, within sixty days of publication. A coupon worth $10 toward the following year’s membership will then be sent to the author.

d. If the original letter was published in a language other than English, the letter must be accompanied by an English translation or summary.

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By 11:30 (a.m.) EST (USA) on Tuesday 11 August 1998, the JForth download site had been deluged with hundreds of download requests, overwhelming the system. The system went down for eight hours.

Despite that outage, in the 24-hour period ending midnight of the 11th (the first day), an incredible 1,649 hits had been recorded on the primary site. Auditing is not available for the secondary, ftp site.

In the 21 days after the JForth release on 10 August 1998, the primary download site at www.softsynth.com/jforth had 931 downloads of JForth. The temporary ftp site did not have tracking information (so the actual number is probably a lot higher) and is now closed.

Following the release of JForth freeware on the 10th August 1998, we are now proud to announce the availability of the JForth web site at home.tampabay.rr.com/jforth/.

JForth is an implementation of Forth designed specifically for the Commodore Amiga. JForth uses a 32-bit stack and compiles directly to 68000 machine code. This makes JForth faster than most Forths. JForth also provides an extensive set of tools for accessing the special features of the Amiga. You can call any Amiga Library routine by name and reference any Amiga structure using constructs similar to those of C.

JForth also has some special toolboxes that support simple graphics, Intuition menus, IFF files, and other Amiga features. These toolboxes can be used directly to simplify Amiga programming. Source code for these toolboxes is provided so you can customize them or study them as examples of Amiga programming. JForth also provides over a dozen small sample programs for those, like me, who learn best by example.

JForth also allows you to do things that are unique in the Forth experience, the most dramatic being CLONE. This exceptional utility allows you to create a totally independent, standalone version of your program of minimal size.

Clone will take a compiled JForth program, extract out all of the code and data needed to run it, and re-assemble a smaller version of it. All of the JForth development tools, the name fields and link fields and any other unused words are left behind. The final image size is comparable to images created using a C compiler and linker. Images can be saved with a symbol table for use with WACK or other debuggers (if needed).

The JForth Source Level Debugger can also be used with Cloned programs. Most programs will Clone without modification if they follow a few simple rules regarding run-time initialization of variables or arrays containing Forth addresses.

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(Continued from page 13.)

**What to Include**

- Your name as you wish it to appear in print.
- Your city, state (or province), and nation of residence.
- Brief autobiographical information to share with readers—such as education, relevant employment, your introduction to and use of Forth, current projects, and other interests.
- Your e-mail address for publication, so interested readers can contact you. If you have a personal Web site, you can include that URL as well.
- If your article depends on a specific Forth dialect or implementation, be sure to specify it (e.g., ANS Forth, Forth-83).
- Your complete mailing address, so we can mail complimentary contributor's copies of the issue in which your work appears.
- Permission to post your code, in the form you have sent it to us, on one or more FTP sites so readers can download it; and/or include the URL of an FTP site where you will post the code.
- Daytime and evening telephone numbers and a fax number (if any). These will not be published, and will be used only if we have questions or problems during the editing process.
- If you send hard-copy manuscript, artwork, or disks that need to be returned to you, include a self-addressed envelope with adequate postage affixed to it.

**How to Submit Your Work**

*If in doubt, just ask—we can work out the details.*

**E-mail**

The fastest, most convenient way for us to receive your material is via e-mail to the editor@forth.org address. Binary (e.g., formatted text) files must be uuencoded to be sent as e-mail, but ASCII files can be sent as-is.

*"Snail" mail*

Or, mail a hard copy with PC or Mac diskettes containing your material to FD Editor, c/o the Forth Interest Group.

**File formats**

If your article includes equations or other items highly dependent on your particular software and/or fonts, include a PostScript file. If submitting electronically, so we can generate a reliable hard copy for proofing. Formatted files that can be read by MS Word are acceptable (e.g., RTF, WordPerfect, and many others); or just send the text as ASCII—you can indicate any critical formatting with informal tags, e.g., `<italic>like HTML</italic>`.

**Illustrations**

Figures are black-and-white and can be vector (PostScript) or bitmapped. They likely will be re-drawn for clarity, style, and compatibility.
Two Problems in ANS Forth
(with ANS solutions)

Introduction
I doubt that anyone is happy with all of ANS Forth and that any programmer could not list off three or four things which they would class as significant losses or missed opportunities when ANS is compared to F83. Recently, when I suggested on comp.lang.forth that the biggest “bug” in ANS Forth is the presence of colon-sys on the control-flow (and, therefore, potentially on the data stack), I was exaggerating the problem slightly; I really think it’s the second biggest problem, but I had already found a workaround for the biggest problem, which, in my eyes anyway, is the inability of the programmer to assign the input stream to an arbitrary block of memory.

The ensuing, rather vigorous, response to my assertion on the newsgroup happily led to Elko Tchernev offering a workaround for the colon-sys problem, which he attributed to Wil Baden and so I am now in the fortuitous position of having a solution for my pet ANS-hates. I still don’t like the locals wordset, but at least I don’t need to use it.

I present below a short discussion of how these two questions affect the programmer, a general guide to how to solve them, and finally an example of code which gets around them both and does something useful in its own right; viz., it implements a finite state machine wordset which is then used to build an FSM which translates ASCII text into Plain TeX format.

The Problems
1. The problem with colon-sys is that the programmer has no obvious way of determining whether it exists and, if it does, how big it is. This makes it difficult to take into account, to say the least. The colon-sys problem really comes to the fore in applications where a special form of colon is needed but there is no need to have a special semi-colon. The natural word to turn to at these times is :NONAME but this has the stack diagram ( -- xt colon-sys). If we want the “special colon” to build a word which uses that xt, we have to get it out from under a stack item we do not know the size of. Generally, the solution I have used up to now is to make a special semi-colon to match the new colon word, which performs the normal semi-colon action first, to remove colon-sys, and then does whatever is required to xt. This solution is ugly and annoying.

2. The input stream words such as PARSE, WORD, and >IN seem, at first glance, a gift to the programmer who wants to write a simple parser for text files of various sorts. First impressions are deceiving, however. Since there is no ANS-sanctioned method of setting the input stream without transferring control to the (supposedly) Forth words contained in it (i.e., EVALUATE), it is often the case that the function of these words is re-written by the programmer into words which take an input stream definition c-addr length pair. This is a waste of programmer effort and is plain inelegant when the code manifestly exists in the Forth kernel already. Indeed, just to rub salt into the wound, the “missing” word we are looking for must be a factor of EVALUATE.

The Solutions
1. The size of colon-sys is, in fact, easily determined by a program as it compiles:

   : SOMEWORD [ DEPTH ] LITERAL ... ;

   Since we know from the ANS Forth document that the only thing added to the stack by colon is a colon-sys (or nothing at all, if the control stack is separate), then the depth reported above is the size, on the data stack, of a colon-sys, assuming that nothing was placed on the stack by the program before hand. This allows ROLL or PICK to be used to retrieve items that lie under the colon-sys:

   : GET-XT [ DEPTH ] LITERAL ROLL ;

   : REPORTXT: ( <NAME> -- colon-sys )
       :NAME GET-XT DUP ." New xt is: " .
       CREATE ,
       DOES>
       @ EXECUTE

   This allows the new word REPORTXT to be completed by the normal semi-colon. This method is used below to allow the definition of the FSM’s state’s actions after the state names themselves are defined, making it much easier for states to reference each other.

2. This one is harder and less attractive. To allow a word to use the normal parsing words in an arbitrary region of text, we first ALLOT or ALLOCATE a region of memory big enough for the word which is going to perform the action, plus a space character, plus the length of the text to be parsed. Then we copy in the name of the word, a space character, and finally the text to be parsed. The start address of this buffer is passed, along with its total size, to EVALUATE and hey, presto! the word’s actions are applied to the text following it in memory.

   The example FSM below uses this method to allow the FSM to parse a file, replacing any characters which would give TeX trouble with the required control sequences in the output file.

   A better solution for everyone would be to expose the code in EVALUATE which redirects the input source to the passed string. Call it something like >SOURCE or >INPUT or just READ.

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www.ncl.ac.uk/~n6388131/home.htm

The author’s most visible Forth achievement is Aztec Forth for Win32 machines. He has programmed for 20 years, and currently is in the final year of a Software Engineering Degree at Newcastle University.
The Example

I recently downloaded a very large text from the Gutenberg Project which I wanted to be able to treat as a TeX document. However, some ASCII characters, such as "[" and "]" and "&", are treated as commands by TeX and, additionally, the normal ASCII double quote mark " is better as either " or " in TeX, depending on whether it represents an opening quote mark or a closing quote mark.

Clearly, this was a job for a finite state machine which would scan through the text, outputting most text as it appeared in the original but replacing special characters with their TeX equivalents. It would have two states, expecting the next double quote to be an open or a close, and passing to the other state when a quote mark was encountered.

First, I build a set of words for defining and running an FSM:

```
FSM
FSG
GO
STATES
(STATE)
DONE
ERROR
```

This is the code for these words:

```
VARIABLE FSM

: GO \ simply read the current state and if it is not DONE or ERROR perform its action; repeat.
BEGIN
FSM @ DUP 0>
WHILE
EXECUTE
REPEAT
DROP
;

: DONE 0 FSM ! ;
: ERROR -1 FSM ! ;

\ a reference to a state causes a transition to that state on the next loop through GO
: (STATE) DOES> @ FSM ! ;

\ Declare your states before you start.
: STATES ( n <NAME1> <NAME2> .. <NAMEm> -- )
  0 ?DO CREATE -1 , (STATE) LOOP ;
```

This uses the colon-sys trick discussed in

```
\ the text to set up the state's action without having to make a special form of semi-colon.
: STATE: ( <NAME> -- )
[ DEPTH ] LITERAL ( COLONIZE)
>R :NONAME ( XT COLONSYS |r: COLONSZ)
R> ROLL ( COLONYS XT <NAME> -- )
' >BODY !
;

And that's it! These words are enough to declare any FSM—so let's use them.

ASCII>TeX. Needs the file words and the memory allocation words.

```
: >= < INVERT ;

\ move to next character in the input stream.
: +CHAR ( -- ) 1 >IN +! ;

\ get the next character in the input stream,
\ unless we have run out of stream.
: CHAR> ( -- CHAR TRUE | FALSE)
SOURCE >IN @ >= IF
<IN @ + C@ -1
ELSE DROP 0
THEN
;

\ for keeping the handle of the output file
VARIABLE OUTFILE

\ write a string to the output file.
: >OUT ( ADDR LEN -- ) OUTFILE @ WRITE-FILE
ABORT" Write fail!" ;

\ declare our states
2 STATES NORMAL "WAIT

\ This is the name of the word which will do the work, it is the FSM word GO
: PARSE$ ( -- CADDR LEN ) S" GO " ;

\ This ungainly word makes a dynamic buffer for the input file plus the above string,
\ reads in the input file, closes it (in case we are going to over-write it.), places the action word at the start of the buffer
\ (where we have left room for it) and returns the address of the buffer and the total length.
: GETINPUT ( HANDLE -- ADDR LEN)
DUP >R FILE-SIZE OR
ABORT" File read problem" ( SIZE|r: HNDL)
PARSES NIP + DUP ALLOCATE
ABORT" Out of memory." ( SZ ADDR|H)
TUCK PARSES NIP + SWAP R@ READ-FILE
ABORT" Read failed!" ( ADDR LEN1 |R:HND)
R> CLOSE-FILE DROP
PARSES ( ADDR LEN1 CADDR LEN2)
3 PICK SWAP MOVE \ PUT GO into start of file
PARSES NIP + \ add length of PARSE$ to file
```
\ Converts a character from ASCII to Te\ if \\
\ required, otherwise just passes it through.

: FILTER ( CHAR -- )
CASE
  [ CHAR ] \ OF $" \backslash $" >OUT ENDOF
  [ CHAR ] \ OF $" \{ $" >OUT ENDOF
  [ CHAR ] \ OF $" \} $" >OUT ENDOF
  [ CHAR ] \ OF $" \{ $" >OUT ENDOF
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  [ CHAR ] \ OF $" \{ $" >OUT ENDOF
  [ CHAR ] \ OF $" \{ $" >OUT ENDOF
ENDCASE

\ allows input of a string in "words and spaces" form.

: "WORD" ( "<text>" -- caddr length)
  [ CHAR ] " PARSE 2DROP [ CHAR ] " PARSE ;

\ load the input file, open the output file,
\ run the FSM, and close everything afterward.

: CONVERT ( "<nameFrom>" "<nameTo>" -- )
  "WORD" R/O OPEN-FILE
  ABORT" File not found."
  R "WORD" W/O CREATE-FILE
  ABORT" Can't open output file"
  OUTFILE !
  R> GETINPUT ( ADDR LEN)
  OVER >R \ keep for FREE
  NORMAL EVALUATE \ Start FSM in NORMAL
  R> FREE
  ABORT" Error releasing memory."
  OUTFILE @ CLOSE-FILE
  ABORT" Error closing output file."
  FSM @ 0<
  ABORT" WARNING: Quotes not balanced!"

; Finally, the two states: NORMAL waits for an open quote, "WAIT waits for a close quote.

STATE: NORMAL
  CHAR>
  IF ( CHAR)
  DUP [ CHAR ] " =
  IF DROP S" "" >OUT +CHAR "WAIT
  ELSE FILTER +CHAR
  THEN
  ELSE DONE THEN

STATE: "WAIT
  CHAR>
  IF ( CHAR)
  DUP [ CHAR ] " =
  IF DROP S" "" >OUT +CHAR NORMAL

\ Once compiled, the program is used by typing
CONVERT "filename1" "filename2"

where filename1 is the original ASCII file and filename2 is the new TeX file to be generated.
The current version does not filter the characters ^ and _ or < and > as these rarely appear in the sort of text which I wrote the program to convert.
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