# FORTH DIMENSIONS

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FORTH DIMENSIONS

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FORTH Interest Group
P.O. Box 1105
San Carlos, CA 94070

HISTORICAL PERSPECTIVE

FORTH was created by Mr. Charles H. Moore in 1969 at the National Radio Astronomy Observatory, Charlottesville, VA. It was created out of dissatisfaction with available programming tools, especially for observatory automation.

Mr. Moore and several associates formed FORTH, Inc. in 1973 to the purpose of licensing and support of the FORTH Operating System and Programming Language, and to supply application programming to meet customers’ unique requirements.

The FORTH Interest Group is centered in Northern California. Our membership is over 3,500 worldwide. It was formed in 1978 by FORTH programmers to encourage use of the language by the interchange of ideas through seminars and publications.

PUBLIC NOTICE

Although the FORTH Interest Group specifies all its publications are non-copyright (public domain), several exceptions exist. As a matter of record, we would like to note that the copyright has been retained on the 6809 Assembly listing by Talbott Microsystems and the Alpha-Micro Assembly listing by Robert Berkey. Several conference papers have had copyright reserved. The general statement by FIG cannot be taken an absolute, where the author states otherwise.

FROM THE EDITOR

Hi! I'm happy to say that starting with this issue, I'll be serving as regular editor of FORTH Dimensions. I'd like to thank Carl Street, the previous editor, who has been a great help to me during the transition. Carl has made several important contributions to FORTH Dimensions, such as the writer's kit for helping you submit articles. Carl will rejoin FORTH Dimensions as our advertising director beginning later this year.

I'd also like to thank Roy Martens, the publisher, for suggesting that I take the editor's post, and for teaching me some of the facts of life in magazine publication.

I hope to make this magazine as useful as possible to the greatest number of people. Since most of our readers are still learning FORTH at one level or another, I intend to encourage the publication of tutorials (such as Henry Laxen’s excellent series which continues with this issue), application stories (sure, FORTH is fun, but let's show the world what we can do with it! examples of well-written FORTH code (the best way to learn style is by reading elegant examples), and any ideas, discoveries, impressions or feelings you care to express (this is your magazine, after all!).

In short, we'll be concentrating on how to use FORTH in solving problems.

By contrast, system implementation details are more the responsibility of the individual vendors' documentation. In addition, the FORTH community boasts two organizations devoted to improving and extending the language: the Standards Team and the FORTH Modification Laboratory (FORML). Each of these groups convenes annually, and the proceedings of these conventions (available through FIG) are extremely valuable documents for the advanced study of FORTH.

I'm looking to each of you to help make this the kind of magazine you want it to be, by contributing articles, examples, and letters. We don't have a staff of writers, so everything we print comes from you. (If you want to contribute but don't know what or how, drop me a line. I'll send you the information kit that Carl put together, and answer any questions you may have.)

I hope you enjoy FORTH Dimensions. And remember, I hope to hear from all of you.

Leo Brodie

NEW POLICY

The 79-Standard has been voted on and adopted to serve as a common denominator for transportable FORTH code and for future discussion of FORTH systems. Beginning with the next issue, FORTH DIMENSIONS will give preference to articles that adopt the 79-Standard.

Listings which use words that are not 79-Standard are welcome, but if possible explain such words in a brief glossary with a note that they are not 79-Standard. For instance, if your application addresses the name field of a definition (which is illegal in the Standard), you should supply a glossary description of NFA.

If possible, also include the definition of such a word. High level source is preferred, but if necessary, the definition may be written in assembler.

We hope this policy will encourage unification, eliminate ambiguity, and simplify explanations.
LETTERS

FORTH Application Library

Dear Fig,

As distributors in the UK for FORTH Inc., with a rapidly growing customer base, we are potentially interested in any application software that is generally useful.

Most of our customers are in the process control/industrial/scientific sectors which, by their nature, require fairly specialized and customized software. Nevertheless, we are sure there are many areas of commonly useful software and that such software would be useful even if only as a starting point or guideline, in order to avoid too much reinvention of the wheel.

Such software might be offered as free and unsupported, at media cost, or as a chargeable product. Whichever way, it does not have to be a professional package.

We have an initial enquiry from a user who needs a 3-term controller program for servo control, and some process mathematics for numerical filtering and linear conversion. As he said to us, "surely someone has done this before and written it up enough to be useful?". So can you help? If you're offering something free, we are interested in helping to create and promote viable packages. We'll not make any firmer plans until we hear from you!

Mike Perry

Benchmark Battles

Dear Fig,

I believe that the primary consideration of an implementation be fluidity of use, and not speed or size except when specific problems arise. But after reading the "Product Review" in FORTH Dimensions III/1, page 11 and seeing some benchmarks, I couldn't resist trying the same on my own home-brew implementation. A Z-80, 5100 bus (one wait state on all memory refs). These are the results I got, plus another column correcting for my slower clock (but not for the wait state). I guess I designed for speed.

Just want to stick up for the oil Z-80. If other people can brag about how compact their implementations are, can't I brag about how fast mine is?

Timin Duncan

Bonadio (also in the "Critical Review" editor, I'd like to point out a simple way to "push" a line onto line zero, moving the current line zero and everything else down:

O T U This will be the new line zero
O T X U

The second phrase swaps lines zero and one.--ed.

FORTH in its Own Write

Dear Fig,

The two paragraphs below appeared in an article in BYTE Magazine on pg. 109 of the August 1980 issue. When it first appeared, I agreed with what it was saying but did not feel the need to point it out to others. Now, however, I think that it's time to remind all of us about FORTH and what it isn't. Clearly it isn't any other language.

The most important criticism of FORTH is that its source programs are difficult to read. Some of this impression results from unfamiliarity with a language different from others in common use. However, much of it results from its historical development in systems work and in read-only-memory-based machine control, where very tight programming that sacrifices clarity for memory economy can be justified. Today's trend is strongly toward adequate commenting and design for readability.

FORTH benefits most from a new, different programming style; techniques blindly carried over from other environments can produce cumbersome results.
It still eludes me as to why people insist on building things into FORTH which are "imported" from other language structures and that in most places do not have any logical place in FORTH. Surely they would not be used by a good FORTH programmer. Take as a simple example spacings. FORTH does not impose indentation or strict spacing requirements as do some other constructs, so why do people insist on indenting? I disagree that this contributes to the readability of the language as FORTH is one of the few base constructs in existence. One might say that a first attempt to improve the readability of FORTH should center around removing the cryptological do-dads that are used. For instance, I must be reminded to use "FETCH", Likewise, "!" should be renamed "STORE" and "," changed to "PRINT".

Obviously this is absurd and so is the notion of indentation and other pseudo spacing requirements that some say contribute to "good programming style." Good programming style is writing clear, concise, fast code that does simple things and then using that and other code to construct more complex definitions. This is the premise upon which FORTH was based. I have seen readable code that was sloppily written, too big for the job that it attempted to accomplish and in a single word was abominable. However, it looked neat and clean.

When the FORTH 79 standard was released I applauded. We are all aware of the small ambiguities and possible deficiencies in the standard. However, the standards team must be commended merely because they exist and they at least attempted to create a standard of some kind. Why then don't people write in standard code? It aggravates me to see code attempting to accomplish and in a single word was abominable. However, it looked neat and clean.

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This letter is purposely provocative and I sincerely hope that you decide to publish it. Through it I hope to force a re-evaluation of the way some individuals look at FORTH. Some of us still think that FORTH is elegant because of its simplicity. It is unfortunate that many refuse to see FORTH as the beautiful language that it is, but see it only as another language that they'd like to resemble.

J.T. Currie, Jr.
Virginia Polytechnic Institute
Blacksburg, VA 24061

Well-expressed, on both points! Regarding the use of the 79-Standard, see our "New Policy" at the front of this issue--ed.

Minneapolis Chapter

Dear fig,

Greetings from the Frozen Wasteland:

This letter is to inform you of the formation of a Minneapolis chapter of the FORTH Interest Group. We have had two meetings so far, with attendances of twelve and sixteen respectively. We plan to be meeting once a month. Anyone who is interested should get in contact with us first at the above address.

We hope to start some kind of newsletter in the near future. I've heard that it's possible to get copies of program listings and other handouts which have appeared at Northern California meetings. Could you please let us know how we go about getting copies? I have enclosed a SASE for you to respond.

One of our members is running a Conference Tree (a Flagship for The CommuniTree Group) which we hope to use for interchange of ideas, programs, etc. outside the general meeting, and to complement the newsletter. The phone number for that Tree is (612) 227-0307. The FORTH branch is very sparse right now, however, since we are just getting off the ground.

We are also contacting local computer groups about jointly sponsoring FORTH tutorials for specific machines, and providing a public-domain, turn-key FORTH system that will turn on their machines. We currently have such software for the Apple II, SYM-1, close on an Osborne-1, close on an OSL, and are seeking out a TRS-80 version.

Dear fig,

The special FORTH issue of Dr. Dobb's Journal made a deep impression on me and on my son. My son is since 12 years a system programmer and knows more than a dozen computer programming languages. I am a logician and engineer, code designer and the developer of the only existing proto-model of Interdisciplinary Unified Science and its computer-compatible language, the UNICODE.

Thus, I represent a radically different path of scientific development—disregarded by many because it does not promise immediate financial returns.

My approach is centered on a new and far more encompassing system-idea of the temporary name "brain-system" having a physical-hetero-categorical genetically ordered sequence of models of logic. This sequence has a specific case for present-day formal logic and a corresponding simplified variant of the system-idea: this is the system-idea of the digital computer.

UNICODE is the first specific brain-system programming language. It is a content oriented language, it has powerful semantics and register-techniques. It has "words" which are at the same time total programs for the generation of the invars and "content" the term intends to communicate.

I think to study UNICODE will lead to unexpected breakthrough in the development of programming, especially if thinking has been made elastic and modular by studying FORTH.

I would like to receive the private addresses of a few creative FORTH fans. In the hope of your early reply, I remain...

John Cassady
Northern California Chapter

John Cassady of the Northern California chapter has agreed to serve as a clearinghouse. The Secretary of any FIG Chapter can mail, each month, handouts from his own Chapter's meetings to Mr. Cassady. In return, John will send back one set of all handouts he receives each month, including those from the Northern California meetings. Even if a local Chapter has no handouts, the Secretary must send at least a postcard to indicate the Chapter's continued interest. The

local Chapter's Secretary will make the necessary copies to distribute to members of that Chapter.

So, let's see those handouts from all the Chapters! Write to:

John Cassady
339 15th Street
Oakland, CA 94612

Brain-System

Dear fig,

The special FORTH issue of Dr. Dobb's Journal made a deep impression on me and on my son. My son is since 12 years a system programmer and knows more than a dozen computer programming languages. I am a logician and engineer, code designer and the developer of the only existing proto-model of Interdisciplinary Unified Science and its computer-compatible language, the UNICODE.

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John Cassady
339 15th Street
Oakland, CA 94612
On converting my 6502 fig-FORTH (V1.1) to work with 256 byte disc sectors, I discovered (after many system hang-ups) that WFR’s 'ENCLOSE' primitive is not guaranteed to work with disc sector sizes greater than or equal to 256 bytes in size.

In his 'ENCLOSE,' Bill uses the 6502 Y register to index through the input text stream, but this register is only 8 bits, so if the text stream contains a block of delimiter characters, e.g., 'space' bigger than 256, it will loop forever, as I found to my cost!

When will this occur? Never from the terminal input buffer, which is only 80 characters long.

With a disc sector size of 256 or bigger, if you have an entire sector of spaces in a load screen, then the load will hang up on this chunk of spaces.

If your sector size is bigger than 256, then any chunk of spaces 256 or bigger will hang it.

I encountered this because I decided to emulate John James’ method used on the PDP-11 version, where 'R/W' handles 1K every time, so as far as BLOCK, BUFFER, and ENCLOSE are concerned, the disc block is 1024 bytes, and compiling hung up on any text gap bigger than 256 bytes!

Anyway, I ENCLOSE (ha ha) a revised version of the ENCLOSE primitive which I am now using, which has full 16 bit indexing. I’m sure some assembly language programmer could produce a neater version, but at least I know that this one works.

Keep up the good work.

By the way, I’m willing to act as a fig software exchange/library in the UK, unless there is someone already doing it?
Editor's Note: This article appeared in the last issue, but, unfortunately, without the source code. Here is the article as it should have appeared. Our apologies.

These utilities allow you to have temporary definition (such as compiler words: CASE, OF ENDOF, ENDCASE, GODO, etc.) in the dictionary during compilation and then remove them after compilation. The word TRANSIENT moves the dictionary pointer to the "transient area" which must be above the end of the current dictionary. The temporary definitions are then compiled into this area. Next, the word PERMANENT restores the dictionary to its normal location. Now the application program is compiled and the temporary definitions are removed with the word DISPOSE.

DISPOSE will take a few seconds because it goes through every link (including vocabulary links) and patches them to bypass all words above the dictionary pointer.

NOTE: These words are written in MicroMotion's FORTH-79 but some non-79-Standard words are used. The non-Standard words have the figure FORTH definitions.

```fbrk
FIRST 1000 - CONSTANT TAREA ( Transient area address )
VARIABLE TP TAREA TP ! ( Transient pointer )
HERE TP @ DP ! ;
TRANSIENT ( --- ADDR )
HERE TP @ DP ! ;
PERMANENT ( ADDR --- )
HERE TP ! DP ! ;
DISPOSE ( --- )
TAREA TP ! VOC-LINK
BEGIN DUP
BEGIN @ DUP TAREA U UNTIL DUP ROT ! DUP 0=
UNTIL DROP VOC-LINK @
BEGIN DUP 4 -
BEGIN DUP
BEGIN PFA LFA @ DUP TAREA U
UNTIL DUP ROT PFA LFA ! DUP 0=
UNTIL DROP @ DUP 0=
UNTIL DROP [COMPILE FORTH DEFINITIONS]

{ Example }
TRANSIENT
: CASE ... ;
: OF ... ;
: ENDOF ... ;
PERMANENT
: DEMO1
... CASE
... OF ... ENDOF
... OF ... ENDOF
ENDCASE ;

TRANSIENT
: EQUATE ( N -- )
CREATE ; IMMEDIATE
DOES ) @ STATE @
IF [COMPILE LITERAL THEN ;
7 EQUATE SOME-LONG-WORD-NAME
PERMANENT
: DEMO2
SOME-LONG-WORD-NAME . ; ( SOME-LONG-WORD-NAME is compiled )
SOME-LONG-WORD-NAME . ; ( as a literal )
DISPOSE ( Removes the words EQUATE, SOME-LONG-WORD-NAME, )
( CASE, OF, ENDOF, and ENDCASE from the )
( dictionary. )
DEMO2 7 OK ( Test DEMO2, it prints a seven. )
```

RENEW TODAY!
I have just finished installing fig-FORTH on my NOVA 1200, using the listing I received from fig. Instead of running it standalone, as the fig listing does, I run it as a task under RDOS Rev. 5.00.

So far I have found four bugs or omissions in the listing. They are as follows:

Page 10 of the listing - EMIT does not increment OUT.

[COMPILE] does not work properly. It can be fixed by removing CFA, from line 07 on page 42 of the listing.

VOCABULARY does not work properly. This can be fixed by adding CFA between AT and COMMA on line 53 of page 44.

(FLUSH) can not be accessed until a missing {S} is inserted after FLUSH on line 13 of page 52.

After installing fig-FORTH, I entered the CYBOS editor from the keyboard and used this editor to boot the fig editor listed in the installation manual. After this experience, I am somewhat pessimistic about FORTH's portability between word and byte addressing machines. I had to make quite a few changes before the fig editor would run. Some examples:

BLANKS expects a word address and word count.

COUNT expects a word address and returns a byte address.

HOLD and PAD both return word addresses.

If any RDOS NOVA users would like a copy of my "fig-FORTH" they should feel free to contact me.

R E N E W T O D A Y !
9900 Trace

Heinz F. Lunk
Loevensteiner Ring 17
6501 Wörthstatt
Germany

I have had some trouble getting my 9900 FORTRAN running.

To ease the finding of errors I wrote a program to display all important vectors (IP, W, CODE, R3, SP) and the first 7 stack contents. Even the stack's growing is visible.

I would like to contribute it to you, so you can offer it to all 9900 users with a 100M or similar board.

It was a great luck for me that I did not need the addresses X59 and X57, and I could use it for a branch to the STATUS program. This program is switched off by the code HEX 545 3B4 and switched on by HEX 457 3B4.

The program list contains the routines for terminal input and output, too.

I hope I can help some people with my program,

(a) PRINT PROGRAM
(b) SYSTEM DEPENDENCE CODE FOR 9900 FORTRAN FORTRAN
(c) PRINTING PROGRAM SUPPORT FOR "KEY AND "PRINT" DIRECTIVES"
(d) TO PRINT OUT THE FUNCTIONS AND THE FIRST SEVEN STACK CONTENTS
(e) PRINT QUERY, HIERARCHICAL ORDERING 17, GIUNI WEINSTADT GERMANY. 12/26/70

** số số**

44 FF00 DATA FP00 XOR 1 VECTORS W
46 68 68 DATA FP00 XOR 1 VECTORS PC
4A FF00 DATA FP00 XOR 2 VECTORS W
4C FF00 DATA FP00 XOR 2 VECTORS PC
4E CF00 DATA FP00 XOR 3 VECTORS W
50 FF00 DATA FP00 XOR 3 VECTORS PC
52 DD00 DATA FP00 XOR 4 VECTORS W
54 DD00 DATA FP00 XOR 4 VECTORS PC

** でででで**

(a) READ DATA TO DISPLAY TERMINAL "MEM"
(b) CALL WITH XPR 4003
(c) WRITE A SLOW CODE TO "MEM ADVANCED"

90 68 68 DATA FP00 XOR 1 VECTORS W
92 68 68 DATA FP00 XOR 1 VECTORS PC
94 IF10 22 IHP 22 PRINTABLE INS. ERROR
96 68 IHP IHP INS. ERROR
98 IF10 22 IHP 22 PRINTABLE INS. ERROR
9A IHP IHP INS. ERROR
9C 3200 IHP04 IHP04 INS. ERROR
9E IF10 22 IHP 22 PRINTABLE INS. ERROR
AE IHP IHP INS. ERROR
B0 3200 IHP

** でででで**

AB 0000 DATA 0000 00,11
AC 82 DATA "MEM"
AE 62 DATA "MEM"
AF 67 DATA "MEM"
B0 C2 DATA "MEM"
C2 32 DATA "MEM"

** でででで**

** SUBROUTINE TO OUTPUT A STRING TERMINATED BY 0 9900 ~ CALL WITH XPR ADDRESS ?
** SUBROUTINE TO OUTPUT A DECIMAL WORD ** CALL XPR SOURCE, 4
** SUBROUTINE TO OUTPUT A DECIMAL WORD ** CALL XPR SOURCE, 4
** PRINT STATER PROGRAM ** USE FOR PRINTING DURING SET UP
** SUBROUTINE TO OUTPUT A STRING TERMINATED BY 0 9900 ~ CALL WITH XPR ADDRESS ?
** PRINT STATER PROGRAM ** USE FOR PRINTING DURING SET UP
** SUBROUTINE TO OUTPUT A STRING TERMINATED BY 0 9900 ~ CALL WITH XPR ADDRESS ?
** PRINT STATER PROGRAM ** USE FOR PRINTING DURING SET UP

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A TECHNIQUES TUTORIAL: EXECUTION VECTORS

Henry Lexen
Lexen & Harris Inc.
24301 Southland Drive
Hayward, CA 94545

This month, we continue our exploration of FORTH programming techniques by taking a look at a concept known as Execution Vectors. This is really a fancy name for very simple concept, namely using a variable to hold a pointer to a routine that is to be executed later.

It is only fair to warn you that the dialect of FORTH that I am using is the one discussed in Starting FORTH by Leo Brodie. It has several differences from figFORTH, not the least of which is the fact that in figFORTH EXECUTE operates on code field addresses (pfa's), while in Starting FORTH EXECUTE operates on parameter field addresses (pfa's). This may not seem like a big deal, but if you ever have fed EXECUTE a pfa when it was expecting a cfa, you have undoubtedly remembered the result. Anyway, my EXECUTE uses pfa's. Its function is to perform or EXECUTE the word that this pfa points to. An example will clear this up. Suppose we have the following:

: GREET . "HELLO, HOW ARE YOU" ;
' GREET ( LEAVE THE PFA OF GREET ON THE STACK ) EXECUTE ( AND NOW PERFORM IT ) the result is:
HELLO, HOW ARE YOU
which is the same result as just typing GREET.

The above may not seem too significant, but the implications are tremendous. Consider the following examples:

VARIABLE 'EMIT
: EMIT ( CHAR -- )
'EMIT @ EXECUTE ;
' ( EMIT ) EMIT :

I assume that (EMIT) is a routine which takes a character from the stack and sends it to the terminal. By defining EMIT to use 'EMIT as an execution vector, we now have the ability to redirect the output of FORTH in any manner we choose. For example, suppose we want all control characters to be sent to the screen to be prefixed with a caret. We could do the following:

' CONTROL-EMIT ( CHAR -- ) DUP 32 ( BLANK ) < IF ( Control Char? ) 94 ( ' ) EMIT ( Yes, emit an ' ) THEN EMIT 1
' CONTROL-EMIT ' EMIT !

Now all regular characters will fail the test, since they will be larger than blanks.

However, control characters will succeed and will be incremented by 64, making them displayable.

There are several other FORTH words that have proven useful to vector. Some of these include:

KEY input from keyboard primitive
CREATE change header structures
LOAD useful for many utilities
R/W disk i/o primitive

EXECUTE uses pfa's. Its function is to take a character from the stack and use it as an execution vector, or to print a screen.

For example, if LOAD were vectored, then by redefining it to print a screen instead of loading it, you could write a print utility which prints screens in load order by LOADing a load screen and redefining LOAD to print. This could be changed to add the screen number of each definition to the dictionary header so that it could later be retrieved with VIEW or the equivalent. KEY may be changed to get its characters from a file somewhere instead of the keyboard. In short, there are a thousand and one uses for Execution Vectors.

But be careful, I may have opened Pandora's box with the above selling job. There is a price to be paid for execution vectors, and that is complexity, the arch-enemy of reliability. Every word that you decide to vector at least doubles the complexity of the FORTH system you are running, since it introduces at least two or more states that the system can be in. You must now also know what the version is of each execution vector you are using. If you have 3 different EMITs and 2 different KEYSs and 3 different LOADs, you have a total of 18 different states that the system can be in just on these vectors alone. So use vectors sparingly, otherwise you will lose control of the complexity very quickly.

Having decided to use execution vectors, we're now faced with different approaches towards implementing them. The one described above works, and is used by many people, but it has one unfortunate property, namely the need to name a variable which is basically overhead. Here is another way to accomplish the same thing without having to define a variable. Consider the following:

DIE ( --- )
1 ABORT "THIS WOULD HAVE CRASHED" ;
EXECUTE
CREATE ( --- )
64 A @ IS 1 + * ( and convert it )
THEN EXECUTE
IS ( PFA --- )

DIE is used to send an error message to the terminal and reset the FORTH system into a clean state. EXECUTE: is a defining word which initializes itself to DIE, but hopefully will be changed later by the user. Words defined with EXECUTE: can be changed with IS as follows:

EXECUTE: EMIT
' ( EMIT ) IS EMIT (or perhaps)
' CONTROL-EMIT IS EMIT

What EXECUTE: has done is combined the variable name with the Execution Vector name into one name. IS is used as a convenience, so that the user can forget the internal structure of words defined by EXECUTE:. Also it provides an extremely readable way of redefining Execution Vectors. Notice that as defined, IS may only be used during interpretation. I leave it as an exercise for the reader to define an IS that may be compiled within : definitions.

Another approach to redefining execution vectors is via the word ASSIGN. It could be defined as follows:

ASSIGN: ( ASSIGN )
IS 24 SWAP 1
' ASSIGN ( --- )
IS ADDRESS ( ASSIGN )
' * IS ADDRESS 1 IMMEDIATE

It would be used as follows:

ASSIGN ( --- )
' ' EMIT ASSIGN
DUP 96 1 ADDI A+1 > IF
DUP 123 1 ADDI A+1 > IF
32 THEN
( EMIT ) ( AS ALWAYS ) ;

When UPPER-ONLY is executed, EMIT is redefined to execute the code following the ASSIGN, which will convert all lower case characters to upper case, and send them to the terminal. Note that unlike IS, ASSIGN may only be used within : definitions.

That's all for now, good luck, and may the FORTH be with you.
CHARLES MOORE'S BASIC COMPILER REVISITED

Michael Perry

In this paper I will discuss several interesting features of the "BASIC Compiler in FORTH" by Charles Moore (1981 FORML Proceedings).

Why is a BASIC compiler interesting? There are a number of reasons. Foremost of them is that BASIC is in many ways typical of a variety of popular languages, particularly FORTRAN, PASCAL, and ADA. Conspicuous features of these languages are algebraic notation, lack of access to the underlying hardware, poor input and output facilities, and non-extensibility. FORTRAN and BASIC also suffer from poor structuring due to the extensive use of GOTO. These languages all tend to be best at solving equations. Other prominent features of BASIC are its use of statement numbers as labels, low overhead, and its use of a few complicated functions (e.g., PRINT) rather than many simple ones.

Why is it slow? BASIC interpreters usually convert source code statements to an intermediate form, where keywords become tokens. The token interpreter is slow because tokens must be deciphered (translated into actions) at run time. This BASIC to FORTH compiler produces code which runs unusually fast. This is because it produces FORTH object code, i.e., sequences of addresses of code routines.

You should look at the example programs (blocks 80-82) before reading the text. You will notice that each BASIC program becomes a FORTH word named RUN. It is executed by typing its name, i.e., RUN. This is how BASIC usually works; you type RUN to execute the program. It serves to demonstrate that from FORTH's point of view, BASIC only knows one "word," RUN. Is it not more useful and flexible to let routines have any name, and to be able to execute any of them by typing its name? Yes, and that is a key feature of FORTH.

How It Works

I will refrain from commenting on the intrinsic value of a BASIC compiler; that has already been covered well in Moore's paper. The principal features I will discuss are the handling of operator precedence, variables in algebraic equations, and the use of the FORTH compiler. The most important part of this BASIC compiler is its ability to convert algebraic (infix) source code to reverse polish (postfix) object code.

A BASIC program is compiled inside the colon definition of a word named RUN. This means that the FORTH system is in its compile state, and any words to be executed during compilation must be immediate. This use of the FORTH compiler was perhaps my greatest lesson from studying this BASIC compiler. The ordinary FORTH compiler is far more versatile than I had realized. If I had written this compiler, it would doubtless have run in the execution state and would have been far more complicated as a result.

Let's look at an example. The BASIC statement

10 LET X = A + B

will be compiled into object code equivalent to the FORTH expression

X A @ B @ + SWAP!

where X, A, and B are variables. One of the variables (X) returns an address, the rest return values (with a fetch). The add is compiled after the fetches the values to be added. The equals becomes the "SWAP!" at the end. Because the source code (in BASIC) is in algebraic notation, and the FORTH object code is in reverse polish order, some way is needed to change the order of operations when compiling the BASIC program. The mechanism which controls the compilation order is based on the idea of operator precedence, which means that some operators are assigned higher priority than others.

PRECEDENCE

The idea of operator precedence is a prominent feature of most computer languages (FORTH is a notable exception). Operations are not necessarily performed in the order you specify. An example will help. The equation X = 5 + 7 * 2 could mean either X = (5 + 7) * 2 or X = 5 + (7 * 2), usually the latter. In algebraic languages some method is needed to clarify the order of evaluation of operators in expressions. That is what precedence does. Each operation is assigned a precedence level. Operations with higher precedence are performed earlier.

During compilation of the BASIC program (the FORTH word named RUN) the compilation of many words is deferred. This allows the order of words to differ between the source code and the object code. Take "=` as an example. To defer compilation of "=` a new word is created which is immediate (and so executes at compile time). When this new word is executed, it leaves the address of "=" on the stack, and on top it leaves the precedence value of 1+. The defining word PRECEDENCE creates the new word as follows: "2 PRECEDENCE +". This creates a new, immediate word named '+', which will leave the address of the old word '+' under the value 2.

The word which decides how long to defer compilation is DEFER. DEFER looks at two pairs of numbers on the stack. Each pair consists of an address and a precedence value. If the precedence of the top pair is larger than that of the lower, DEFER does nothing. If the top precedence is less than or equal to the one below, the address part of the lower pair is copied, and its precedence is discarded. DEFER will continue to compile until the upper precedence is larger than the lower.

So how do you get started? Essentially, most BASIC keywords (such as LET) execute START which leaves NOTHING on the stack, where "NOTHING is the address of a do nothing routine and 0 is its precedence. This pair will remain on the stack during the compilation of that statement, because everything has higher than zero precedence.

At the end of each line, RPN is executed. It performs a 0 1 DEFER, which forces the compilation of any deferred words, because every operator has a precedence at least 0, and 0 executes NOTHING. Actually, each statement is ended by the start of the next. BASIC keywords such as LET execute STATEMENT, which contains RPN to finish the statement and START (to begin the next).

BRANCHING

Three new branching primitives are used. They are compiled by various higher level words. JUMP is used by GOTO. SKIP and JUMP are used by IF-THEN. JUMP is compiled followed by an absolute address. When executed it simply loads that address into the IP (virtual machine instruction pointer). When SKIP executes, it takes a boolean off the stack. If true it adds 4 to the IP, skipping (usually) the following JUMP.

(NEXT) is used for FOR-NEXT loops. It is compiled followed by an absolute address. When executed it takes three parameters from the stack: final value of the loop index, step size, and the address of the variable containing the current value of the loop index. It adds the step (plus or minus) to the variable, and loops until the index passes the limit.

Adding GOSUB would require another branching primitive, CALL.
STATEMENT NUMBERS

Each BASIC statement must be preceded by a number. This number acts as a label, allowing branches between lines. In this compiler, the numerical value of the labels does not affect execution order. When a statement number is encountered, it is compiled in line as a literal. The address of LIT is compiled followed by the labels does not affect execution order. When a statement number is encountered, 10 is compiled in line as a literal. The literal value 10. For example, when the statement 50 is compiled, the line number just compiled to the new statement. STATEMENT NUMBERS

When a forward reference occurs, as in "GOTO 50" before statement 50 is compiled, GOTO compiles 'JUMP 0'. The zero will later be replaced by the address of line 50. The reference is entered into the table with the address to be patched instead of the actual address of statement 50. Additional forward references to the same point will be chained to each other. To indicate that this is a forward reference, the address in the table is negated. This means that BASIC programs must be compiled below 8000H, so that all addresses appear to be positive. Here simplicity was chosen over generality.

VARIABLES

There are two particularly interesting things to notice about variables. They are immediate, and they know which side of an equation they are on. Three types of variables are supported: integers, arrays, and two dimensional arrays. Variables must be declared (defined) before use. The BASIC expressions: LET X = A + B (where X, A, and B are variables) compiles into the following FORTH equivalent:

```
X @ A B + SWAP !
```

Notice that when an integer appears on the left of an equals sign, it must compile its address, and when on the right side, its value (address, fetch). Also note that only one can appear on the left, while many can be on the right.

The way this is implemented is surprisingly simple. The variable ADDRESS contains a flag which indicates which side of the equals sign a variable is on. The word LET sets ADDRESS to 1. "INTEGER X" creates a variable named X, which is immediate. When X is executed it compiles its address. X then examines ADDRESS. If it is true (non-zero), X simply makes it zero. If ADDRESS is false, X compiles a @ after the address, thereby returning the value when the BASIC program is run.

Notice that the equals sign plays no role in this process; everything is done by keywords (e.g., LET) and variables.

Future Directions

Many more features can easily be added to this BASIC compiler. But why bother? A much more fruitful line of endeavor would be to make use of the lessons learned in this compiler to write compilers for other, more useful, languages such as C. A C compiler which is easy to modify and extend, and just as portable as FORTH is, could actually be useful. Another area worthy of effort might be generators for machine code, a common thing for compilers to have.

Conclusions

It is possible to use FORTH to produce portable compilers for other languages. Doing so provides insight into the nature of languages, and the desirability of various approaches to problem solving. Whether the compilers themselves prove useful or not, it is worthwhile to write them.

Transportable Control Structures

With Compiler Security

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This article is an enhancement of the idea presented by Kim Harris at the Rochester FORTH Conference (from the Conference Proceedings, page 97). Basically, the article proposes a wordset of primitives for defining control words such as IF , ELSE , THEN , DO , LOOP , BEGIN , WHILE , REPEAT , UNTIL , AGAIN , CASE , etc. Kim points out that the stack is not answering a >MARK . This method allows some compiler security where it is important not to carry pairs on the stack.

Example:

```
: >MARK HERE 0 , ;
: >RESOLVE DUP @ 0 ?PAIRS HERE SWAP ! ;
: <MARK HERE ;
: <RESOLVE DUP @ NOT 0 ?PAIRS , ;
: IF C , >MARK ;
: ENDIF >RESOLVE ;
: ELSE C3 IF SWAP ENDIF ;
: BEGIN <MARK ;
: UNTIL C , <RESOLVE ;
: AGAIN C3 UNTIL ;
: WHILE IF ;
: REPEAT SWAP AGAIN ENDF ;
```

The word >RESOLVE is filling a gap left by >MARK . If >RESOLVE were to first check to make sure a gap was there ( DUP @ 0 ?PAIRS ) it would help ensure that the value on the stack was indeed left by >MARK . Likewise, if <RESOLVE made sure that the point where it branches back to does not have a gap ( DUP @ NOT 0 ?PAIRS ) it would guarantee that it was not answering a >MARK . This method allows some compiler security where it is important not to carry pairs on the stack.
Michael Perry 1982
78 0 (Charles Moore's BASIC compiler, Input and Output )
 1 : ASK ";" O QUERY ;
 2 : PUT (GET#) PUT ;
 3 : (INPUT) COMPILER ;
 4 : i i i OOVER - SPACES TYPE SPACE ;
 5 : ( ) OIGNORE "();" 1 OREFER : IMMEDIATE
 6 : " ICOMPILER ;" IZWRAP ; IMMEDIATE
 7 INPUT DEFINITIONS
 10 IGNORE RPM O (INPUT) O ADDRESS # O IMMEDIATE
 10 ARITHMETIC DEFINITIONS
 11 : PRINT STATEMENT COMPILER OR (,) O IMMEDIATE
 12 : INPUT STATEMENT COMPILER ASH ( INPUT ) O INPUT
 12 : O ADDRESS # O IMMEDIATE
 14
 15
90 0 ( Driver, page 17, Program 1 ) SCR
 1 INTEGER J O INTEGER K
 2
 3 : RUN START
 4 10 PRINT "THIS IS A COMPUTER"
 5 20 FOR K = 1 TO 10
 6 20 PRINT "NOTHING CAN DO"
 7 40 FOR J = 1 TO 5
 8 50 PRINT "ERROR!"
 9 60 NEXT J
 10 70 NEXT K
 11 90 END
 12
 13 RUN
 14
 15
92 0 ( basic: input/print ) SCR
 1 INTEGER K
 2 INTEGER X
 3 INTEGER Y
 4
 5 : RUN START
 6 10 INPUT X , Y
 7 20 LET X = X + X + 5
 8 60 PRINT X , Y , X
 9 90 END
10
11
12
13
14
15
79 ( Operators )
 1 : OR ( i m - t ) O NOT ;
 2 PRECEDENCE <)
 1 , ( i m - t ) O NOT ;
 2 PRECEDENCE <=
 2 PRECEDENCE =

ARITHMETIC DEFINITIONS
 1 = i m - n 1 SWAP 1 DO OVER * LOOP 1 ;
 6 PRECEDENCE ABS
 2 PRECEDENCE #
 4 PRECEDENCE / 4 PRECEDENCE #
 5 PRECEDENCE - 2 PRECEDENCE -
 2 PRECEDENCE " 2 PRECEDENCE "
21 ( basic: array demo ) SCR
 1 INTEGER K
 9 ARRAY COORDINATE
 10
 11 : RUN START
 12 10 FOR K = 1 TO 9
 13 20 LET COORDINATE K = ( 10 - K ) #
 14 30 PRINT COORDINATE K = 5
 15 40 NEXT K
 16 90 END
 17
 18 RUN

1

******************************************************************************
1

Michael Perry 1981
A ROUNDTABLE ON RECURSION

Recursion, as it applies to FORTH, is the technique of defining a word in such a way that it calls itself. One of the nicest examples I've seen of a good use for recursion can be found in Douglas R. Hofstadter's book Godel, Escher, Bach. He describes a system which can produce grammatically correct phrases out of parts of speech.

I'll use FORTH to describe his example:

```forth
: FANCY-NOUN
  4 CHOOSE
  (select random number 0-3)
  CASE
  0 OF NOUN ENDOF
  1 OF
    NOUN PRONOUN
    VERB FANCY-NOUN ENDOF
  2 OF
    NOUN PRONOUN
    FANCY-NOUN VERB ENDOF
  3 OF
    NOUN PREPOSITION
    FANCY-NOUN ENDOF
ENDCASE;
```

Three of the four possible variations on FANCY-NOUN include a call on FANCY-NOUN itself. Case 0 might produce "books," Case 1 might produce "man who reads books." But Case 1 might also produce something more complicated, like "man who reads books that explain algebra," if the inner call to FANCY-NOUN decides to get fancy.

Normally FORTH deliberately prevents recursion so that you can call an existing word inside the definition of a new definition of the same name. For example:

```forth
: + SHOW-STACK + SHOW-STACK ;
```

This example might be a redefinition of plus to teach beginners what the stack looks like before and after addition. The plus that is called in the middle of the definition is the original +, not the one being defined.

FORTH prevents recursion with a word called SMUDGE. This word usually toggles a bit in the name field of the word most recently defined. With this bit toggled, the name is "smudged"; that is, unrecognizable. In the definition of + above, the colon lays down a head in the dictionary, and then executes SMUDGE before compiling the rest of the definition.

When the second + is encountered, the compiler searches the dictionary for a word of that name. The new head with the same name is bypassed only because it has been smudged.

At the end of the definition, semi-colon again executes SMUDGE. This toggles the bit back to its original state, so that the name is again findable.

There are various means of circumventing FORTH's protection against recursion. Here are two recent contributions from our readers:

**A Recursion Technique**

Christopher P. Kuklules
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Here is my solution to the problem of recursion in FORTH shown in a possible way to implement the ACKERMANN's function (see FORTH DIMENSIONS, Vol. III, No. 3, p. 99).

First test if your FORTH-system is "crash-proof" with the following sequence:

```forth
SMUDGE SMUDGE CRASH;
```

After having recovered from CRASH you should try this:

```forth
(m n -> ACKERMANN (m n))
ACKERMANN ( m n -> ACKERMANN
  (SMUDGE) SWAP DUP 0s IF DROP 1-
  ELSE SWAP DUP O= IF DROP 1 - 1
  ELSE OVER SWAP DUP 1 - ACKERMANN
  THEN SWAP ACKERMANN
  THEN SMUDGE CRASH
)
```

Be aware of typing if you like readable, since smudging has nothing to do with what the definition is about, and 2) its behavior is different on different systems.

Similarly, having to say RECURS ACKERMANN RECURS is not quite as readable as simply MYSELF.

An even more readable solution is this:

```forth
: R
  [COMPILE] : SMUDGE ; IMMEDIATE
  R
  [COMPILE] ; IMMEDIATE

SMUDGE [COMPILE] ; IMMEDIATE

Here a special version of colon and of semi-colon named R and R; are defined to allow recursion without any other hoops.
```

**Another Recursion**

Arthur J. Smith
Osahawa Canada L1G 6P7

Regarding the recursion problem, I think that I have found a more elegant solution. The solution involves an immediately executed word to remove SMUDGE the word being defined.

I define a word RECURS as follows:

```forth
: RECURS SMUDGE ; IMMEDIATE
```

Then use the word to bracket the recursive self definition as in the example:

**RENEW TODAY!**
This 8080 assembler has been available in a slightly different form for approximately one and one-half years. It appears to be bug-free.

ENDIF's have been replaced by THEN, and AGAIN has been removed in conformance with FORTH-79. I have never had occasion to use AGAIN; I doubt if I'll miss it.

I have removed the compiler security. We frequently want non-structured control mechanisms at the code level. The ?PAIRS really gets in the way.

The actual address of NEXT is stored in (NEXT). Its value is plucked from MVI and LVI as opposed to an immediate flag.

The conditional jumps are, of course, handled automatically by the conditionals: IF WHILE and UNTIL, in conjunction with the flag testers: 0 = CS PE 0 < and NOT.

I have opted to retain the immediate instructions MVI and LVI as opposed to an immediate flag #.

The 1M1 2M1 etc stands for "number one machine instruction" etc. The first out of this assembler was written when three letter names were the craze.

I have a selfish motive in publishing this assembler. I hope that this will flush out assemblers for other processors and that there will be a "rush to publish." There is a good reason to do this besides vanity. If someone else publishes the assembler for the "xyz" chip that you use, and it becomes established, it means that you will have to change your code to conform with the quirks of the "established" version. It pays to get there first.
Screen 51 33H
0 ( EXAMPLES USING FORTH 8080 ASSEMBLER 1 81AUG17 JJC 80MAR12 )
1 FORTH DEFINITIONS HEX
2 CODE CSWAP ( WORD-1- SWAPS HI AND LOW BYTE OF WORD ON STACK )
3 H POP L A MOV H L MOV A H MOV FSH C
4 CODE LCFLD ( FROM-2 QTY-1- CONVERTS LOWER CASE TO UPPER )
5 D POP H POP
6 BEGIN D A MOV E ORA 0= NOT
7 WHILE M A MOV 60 CPI CS NOT
8 IF 20 SUI A M MOV
9 THEN D DCX H INX
10 REPEAT NEXT C;
11 ;S
12
13
14
15

Screen 52 34H
0 ( EXAMPLES USING FORTH 8080 ASSEMBLER 2 81AUG17 JJC 80MAR12 )
1 CODE CMOVE ( FROM-3 TO-2 QTY-1- SAME AS IN NUCLEUS )
2 C L MOV B H MOV B POP D POP XTHL
3 BEGIN B A MOV C ORA 0= NOT
4 WHILE M A MOV H INX D STAX D INX B DCX
5 REPEAT B POP NEXT C;
6 CODE CMOMOVE ( FROM-3 TO-2 QTY-1- SAME BUT OPD DIRECTION )
7 C L MOV B H MOV B POP XCXO
8 H POP 3 DAD XCX XTHL B DAD
9 BEGIN B A MOV C ORA 0= NOT
10 WHILE H DCX M A MOV D DCX D STAX B DCX
11 REPEAT B POP NEXT C;
12 END.
13 ;S
14
15

Screen 53 35H
0 ( EXAMPLES USING FORTH 8080 ASSEMBLER 3 81AUG17 JJC 80MAR12 )
1 80 CONSTANT CMMD ( COMMAND BYTE )
2 F0 CONSTANT CMMDPORT ( COMMAND PORT )
3 F1 CONSTANT STATUSPORT ( STATUS PORT )
4 LABEL DELAY ( --- DELAY CONSTANT IN DE, DON'T USE THE STACK )
5 BEGIN D DCX D A MOV E ORA 0= UNTIL RET C;
6 CODE STATUS ( BIT MASK-1- )
7 1 PO CMMD A MOD CMMDPORT OUT
8 1234: LXC DELAY CALL
9 BEGIN
10 STATUSPORT IN L ANA 0= NOT
11 UNTIL NEXT C;
12 ;S

Sieve of Eratosthenes
In FORTH

Mitchell E. Timin
Timin Engineering Co.

The enclosed version of Eratosthenes Sieve was written for an implementation of Timin FORTH release 3. I was pleased that it executed in 75.9 seconds, as compared to the 85 seconds of figFORTH. Mine was run on a 4 MHz Z-80 machine, as were the others in the BYTE magazine article.

The speed improvement is primarily due to the array handling capability of Timin FORTH release 3. FLAGS is created with the defining word STRING; nFLAGS leaves the address of the nth element of FLAGS. This calculation occurs in machine code.

SCR # 35
0 I ( The Sieve of Eratosthenes, after J. Gilbreath. BYTE 9/81 )
1 1900 CONSTANT SIZE SIZE STRING FLAGS ( make array of flags )
2 I PRIME 0 FLAGS SIZE 1 FILL ( start by setting the flags )
3 0 1 ( create counter which remains on top of stack )
4 SIZE 0 DO ( repeat following loop 1900 times )
5 I Flags CE ( fetch next flag to top of stack )
6 IF ( if flag is true then do the following: )
7 I DUP + 3 * ( calculate the prime number )
8 DUP 1+ ( stack is: counter, prime, K )
9 BEGIN DUP SIZE < WHILE ( repeat for K < SIZE )
10 OVER FLAGS C! ( clear Kth flag )
11 OVER + ADD PRIME TO K
12 DO REPEAT DROP DROP 1+ ( drop K & prime, increment counter )
13 ENDIF ( finish display count )
14 LOOP 3 SPACES ' PRIMES ' ( display the count )

SCR # 36
0 I ( testing the sieve algorithm ) O VARIABLE KOUNT
1 J BELL 7 EMIT ;
2 I NEW-LINE? OR O OUT ;
3 I NEW-LINE? OUT 0 70 > IF NEW-LINE ENDF;
4 I PRIME-TEST BELL ( first sound the bell )
5 10 0 DO PRIME LOOP BELL ( run the prime finder 10 X )
6 7 ABOVE IS FOR TIMING TEST, BELOW IS FOR VALIDATION
7 0 KOUNT NEW-LINE ( clear counter, start new line )
8 SIZE 0 DO ( check each flag )
9 I Flags CE ( see if it's set )
10 I DUP + 3 * ( calculate the prime number )
11 7, R NEW-LINE? DISPLAY IT
12 KOUNT +1 ( count it )
13 ENDIF ( display the count )
14 LOOP OR KOUNT ? * ' PRIMES ' ; ( display the count )
In regard to Michael Burton's article in FORTH DIMENSIONS, III/2, page 53, "Increasing fig-FORTH Disk Access Speed," I enclose a simple mod to the 8080 or Z80 assembly list to effect the CP/M skewed sector disk I/O. The FORTH routines I used to test the scheme are included. The first cluster or screen is offset by 52 sectors so that the operating system is transparent and screens 0 and 1 hold the directory. I move the message screens to SCR# 24 and 25 leaving 2-20 for the FORTH binary program run by CP/M or CDOS.

In order to check any increase in disk access speed I timed the following operation with a 10 screen buffer:

```
20 270 10 MCOPY 20 270 10 MCOPY
20 270 10 MCOPY
```

Elapsed times were 204 and 138 seconds for straight and skewed sectors respectively. Note that this reflects disk access speed for read/write of several sequential sectors and in no way compensates for inadequate planning or poor programming in other disk I/O applications.

If this seems trivial, then you have no need for CP/M file compatible I/O. My motive for these changes is the desire to write the assembler program for fig-FORTH via modem (easy to implement in FORTH) to friends and colleagues. As added value my disk I/O can be faster.

Roger D. Knapp

---

**SKEWED SECTORS FOR CP/M**

```
30 TO
LD D,DE,SETDR : SEND DRIVE # TO CP/M
CALL IOS
PVP DC ; RESTORE (IP)
JP NEXT
30 JRTBL: DB 0,1,2,3,4,5,6,7,8,9,10,11,12,13,14
DB 15,16,17,18,19,20,21,22,23,24,25,26,27,28,29
DB 30,31,32,33,34,35,36,37,38,39,40,41,42,43,44
DB 45,46,47,48,49,50,51,52,53,54,55,56,57,58,59
DB 60,61,62,63,64,65,66,67,68,69,70,71,72,73,74
DB 75,76,77,78,79,80,81,82,83,84,85,86,87,88,89
DB 90,91,92,93,94,95,96,97,98,99,100,101,102,103
DB 116,117,118,119,120,121,122,123,124,125,126,127
DB 128,129,130,131,132,133,134,135,136,137,138,139
DB 140,141,142,143,144,145,146,147,148,149,150,151
DB 152,153,154,155,156,157,158,159,160,161,162,163
DB 164,165,166,167,168,169,170,171,172,173,174,175
DB 176,177,178,179,180,181,182,183,184,185,186,187
DB 188,189,190,191,192,193,194,195,196,197,198,199
DB 200,201,202,203,204,205,206,207,208,209,210,211
DB 212,213,214,215,216,217,218,219,220,221,222,223
DB 224,225,226,227,228,229,230,231,232,233,234,235
DB 236,237,238,239,240,241,242,243,244,245,246,247
DB 248,249,250,251,252,253,254,255
30 SSKEU: DB 5,2 ; SECTOR SEQUENTIAL
30 ADD DB 'S-K' ; ADDR OF NEW SECTOR
30 POP DB E, HL ; SECTOR TRANSLATED
30 JP NEXT

; ADDED AFTER "SET DRIVE"

---

### SCR# 40

```
( CP/M style disk layout and I/O )
4 PRINT DEFINITIONS DECIMAL
2
9
12
10
11
3
5
7
9
10
12
14
15
17
```

---

**FORTH DIMENSIONS III/6**
SCR # 61
0 ( SECTOR SKEW FOR CP/M FORMAT CLUSTERS )
1 2:0 FORTH DEFINITIONS DECIMAL
2 SCR, #27, 5:2:0 CP/M FORMAT CLUSTERS

SCR # 49
0 ( MORE CP/M FORMAT DISK I/O )
1 2:0 FORTH DEFINITIONS DECIMAL
2 SCR, #27, 5:2:0 CP/M FORMAT DISK I/O

SCR # 90
0 ( B/SCR TDH 7/11/81 )
1 2:0 B/SCR ( display addr of all buffers )
2 OR 12.7 2 SPACES
3 DUP 2+ HEX 6 0 SWAP D.R DECIMAL 3 SPACES
4 #IO B/SCR /MOD 5.R 4 SPACES 2.R
5 0= 0= 32 + EMIT 2 SPACES
6 DUP 32767 AND DUP 6.R 4 SPACES 2.R
7 B/SCR /MOD 5.R 4 SPACES 2.R
8 132 + ?TERMINAL IF LEAVE THEN
9 LOOP DROP ON ;
10
OK

BUFFS
# Addr(hex) Upd Block# Screen -sub
1 7862 720 90 0
2 3056 721 90 1
3 328A 722 90 2
4 400E 727 90 3
5 4092 728 90 4
6 411E 729 90 5
7 421E 726 90 6
8 421E 727 90 7
9 42A2 0 0 0

Diagnostics on Disk Buffers

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While I was in the process of explaining the disking to some friends, I found it would be nice to show them some sort of representation which lists all the disk buffer status. This short program was then written for this purpose.

The figFORTH uses the memory above USER area for the disk buffer. This disk buffer area is further divided into several blocks with the length of each block equal to B/BUF + 4 bytes. There are some implementations that set B/BUF to be 1024 bytes and some, like 8080 CP/M, that set it to be 128 bytes. Another constant besides B/BUF frequently referred in disking is the B/SCR (buffers per screen). For B/BUF = 1024, the B/SCR = 4 and for B/BUF = 128, B/SCR = 8.

Each block needs 2 bytes in front of it as the header which contains the update bit (bit 15) and block number (lower 0-14 bits). It also needs a 2-byte tail to end the block.

The word BLOCK will put the beginning address of a given block (assuming the block number on stack before executing BLOCK). With these simple words, virtual memory can be utilized, but it is beyond the scope of this short article.

The short program will display the status of each disk block until it is exhausted or you terminate it by pressing any key. The first thing it does is print out the title line (line 4). Line 5 sets up the boundary for the DO ... LOOP. Line 6 prints the buffer number while line 7 prints the beginning address of each buffer in hex. Lines 8 and 9 check the buffer update status. If it has been updated, then an "*" will be printed in the upd column. Lines 10 and 11 calculate the block number, screen number and the -sub number. The reason for teh -sub is because for my system, B/BUF = 128, B/SCR = 8, there are 8 blocks to make a whole screen. So, I thought it would be handier to know which subpart of a given screen the block I want.

Lines 12 and 13 check the early termination and finish the definition.
FLOATING POINT ON THE TRS-80

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Most FORTH systems have no provisions for handling floating point numbers, although most popular micros have the necessary routines hidden in their ROM-based BASIC interpreter. These are fast routines written in assembler. The following is to demonstrate how these can be accessed and used to implement single precision floating point arithmetics for the TRS-80 in MMSFORTH, Version 1.8.

Single precision floating point data is stored as a normalized binary fraction, with an assumed most significant bit representing the sign bit. The most significant bit also doubles as a sign bit.

A binary exponent takes one byte in each floating point number. It is kept in excess 128 form; that is, 128 is added to the actual binary exponent needed.

Most FORTH systems have no provisions for handling floating point numbers (two 16-bit words each). In figFORTH (specify) is available for microsystems. It includes both single and double precision, trigonometric and log functions, floating point constant, variable and stack operators, conversion routines to/from integers (FORTH type) and floating point numbers.

The complete vocabulary and listing of the source screens for either MMSFORTH or figFORTH (specify) is available for $7 (U.S.) from Kalth microsystems. It includes both single and double precision, trigonometric and log functions, floating point constant, variable and stack operators, conversion routines to/from integers (FORTH type) and floating point numbers.

GLOSSARY

Single Precision Floating Point

<table>
<thead>
<tr>
<th>Operation</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add</td>
<td>F+</td>
<td>(F1 F1 -- F)</td>
</tr>
<tr>
<td>Subtract</td>
<td>F-</td>
<td>(F2 F1 -- F)</td>
</tr>
<tr>
<td>Multiply</td>
<td>F*</td>
<td>(F2 F1 -- F)</td>
</tr>
<tr>
<td>Divide</td>
<td>F/</td>
<td>(F2 F1 -- F)</td>
</tr>
</tbody>
</table>

Notes: A -- 16 bit address

F TEST ( -- )

A sample program to demonstrate the use of these floating point operators. It asks for a floating point number from the keyboard, manipulates it using all the operators defined and prints the result. (It should be the same number that was supplied.)

Notes: A -- 16 bit address

F, F1, F2 -- are single precision floating point numbers (two 16-bit words each).

BLOCK 9

0 ( FPP #1 :KIP 810816) FORGET FPASK : FPASK ; HEX
1 ( SINGLE PREC. FLOATING POINT FOR TRS-80 IN MMSFORTH V1.8)
2 : EXX D0 C ;
3 CODE F & EXX 0FBD CALL 2BA7 CALL EXX NEXT
4 CODE F #& EXX HL POP 2 HLT CALL
5 0AB1 CALL EXX NEXT
6 : F# DUP 2 + @ SWAP & 4 40AP CI ;
7 : F1 DIP ROT SWAP 1 + 1 4 40AP CI ;
8 : A S 4121 F# ;
9 : #0 HERE 0 OVER 3E PILL BL WORD F# A S ;
10 : F#IN " ? " PAD DUP 1 + 63 EXPECT F# A S ;
11 : F#1 F#0 SWAP (L) (L) , , (L) (L) , , ;
12 : F# STATE_CW IF F#1 ELSE F#0 THEN IMMEDIATE
13 : P S A F. & 4 40AP C ; DECIMAL
14 : 10FT ;
15

BLOCK 10

0 ( PLOT_PT. #2 :IF 810816) FORGET 10FT : 10FT ;
1 HEX
2 CODE F + & EXX DE POP BC POP BC POP 716 CALL EXX NEXT
3 CODE F - & EXX DE POP BC POP BC POP 713 CALL EXX NEXT
4 CODE F #& EXX DE POP BC POP BC POP 847 CALL EXX NEXT
5 CODE F #& EXX DE POP BC POP BC POP 8A2 CALL EXX NEXT
6 : F+ S A F+ & A S ; : F- S A F- & A S ;
7 : F# S A F# & A S ;
8 DECIMAL
9 ( SAMPLE AND TEST ROUTINES)
10 : FTASK F#IN CH F# 2 F+ F# 200.0E-2 F-
11 : F# 5000.1 F* F# 5.000E+3 F/
12 : PAD F+ PAD F# F- ;
13 ;S
14
15
Occasionally in writing a definition, I find that I need to do unwieldy stack juggling. For example, suppose you come into a word with the length, width, and height of a box and want to return the volume, surface area, and length of edges. Try it!

For this kind of situation I developed my ARGUMENTS-RESULTS words. The middle block of the triad shows my solution to the problem.

The phrase "3 ARGUMENTS" assigns the names of local variables 1 through 9 to nine stack positions, with S1, S2, and S3 returning the top 3 stack values that were there before ARGUMENTS was executed. S4 through S9 are zero-filled and the stackpointer is set to just below S9.

S1 through S9 act as local variables returning their contents, not their addresses. To write to them you precede them with the word "TO". For example, 5 TO S4 writes a 5 into S4. Execution of S4 returns a 5 to the stack.

After all calculating is done, the phrase "3 RESULTS" leaves that many results on the stack relative to the stack position when ARGUMENTS was executed. All intermediate stack values are lost, which is good because you can leave the stack "dirty" and it doesn't matter.
Accompanying these comments are several graphic specimens drawn on Apple computer using FORTH and printed on a dot-matrix printer. They range from logotype design to experiments in geometry and pattern. One can generate real-time motion graphics on the Apple in which color and action partially compensate for the low resolution of 280 by 192 pixels. Hardcopy, whether printout or color photo, isn't the final product. The interactive, sequenced and timed display on the screen is the designed product, likely to displace the medium of print on paper in the future.

While these graphic samples could have been programmed in other languages, I have found the advantages of using FORTH are both practical and expressive: immediate and modular experimentation with the peculiarities and limitations of the Apple video display, and orchestration of complex visual effects with self-named procedures rather than the tedious plots and pokes to undistinguished addresses. With this ease of wielding visual ideas, FORTH might lead to a new era of computer graphics, even creative expression.

It may remain individual and personal expression, however, without graphics standards. Transportability of graphics-generating code may be neither possible nor desirable considering the differences in video display generation, alternate character sets, shape tables, display lists, interrupts, available colors, etc., between microcomputers. Each has some individual features to exploit. Most have, however, such limited memory for graphics as to make machine-dependent economy an overriding aspect of programming for graphics.

Despite the rarity of FORTH graphics thus far, I'm convinced it is an excellent vehicle for bringing out undiscovered graphics potential of each micro. In addition, the visibility gained by some effort to evolve graphic ideas in FORTH would help in both spreading and teaching the language. Perhaps this issue of FORTH DIMENSIONS will stimulate just such activity.

Editor's Note: The author tells me that Osborne/McGraw-Hill publishers have used his patterns, generated on Apple II using Cap'n Software FORTH, as cover artwork for their book "Some Common BASIC Programs".

Bob Gotsch
California College of Arts and Crafts
CASES CONTINUED

Editor's Note: In Volume II, Number 3, FORTH DIMENSIONS published the results of FIG's CASE Statement Contest. As we had hoped, the variety of responses has stimulated further work on the subject. Here are four additional CASE constructs submitted by our readers.

Eaker's CASE for 8080

John J. Cassady

Here is an 8080 (Z80) version of the keyed case statement by Charles Eaker that was published in FORTH DIMENSIONS II/3, page 37. I have found it very useful.

Eaker's CASE Augmented

Alfred J. Monroe
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Los Angeles, CA 90066

I was delighted with Dr. Eaker's CASE construction (FORTH DIMENSIONS, Vol. II, No. 3, p. 37) and implemented it immediately. Recently I have found it desirable to augment CASE with three additional constructs in order to treat ranges of variables. It has occurred to me that other FORTH users may be interested in the same extension, hence this short note.

Screen 144 lists Dr. Eaker's CASE construct with one slight modification. Of has been modified to use (OF). The original OF compiled to ten bytes. The revised OF compiles to six bytes. This forty percent reduction in code is not as impressive as that which occurs using Dr. Eaker's CODE word (OF) construct, but it does have the advantage that it is highly portable. (OF) tests for equality and leaves a true or false flag on the stack. Note that it drops the test value if the test is true.

Screen 145 lists the extensions that I have found useful, <OF, >OF, and RNG-OF. <OF does a "less than" test, >OF does a "greater than" test. RNG-OF does an inclusive range test. <OF and >OF are trivial modifications of OF and (OF). RANGE and RNG-OF are constructed in the same spirit as (OF) and OF.

Screen 144 compiles to 175 bytes. Screen 145 compiles to 223 bytes.

0 ( CASE STATEMENT BY CHARLES EAKER FD II 3 39 )
1 : CASE <OF CSP @ I CSP 4 ; IMMEDIATE
2 CODE (OF) H POP D POP ' - B + CALL L A MOV H ORA 0=
3 IF B INX B INX NEXT ENDF D PUSH ' BRANCH JMP C;
4 : OF 4 ?PAIRS COMPILE (OF) HERE 0 , 5 ; IMMEDIATE
5 : ENDF 5 ?PAIRS COMPILE BRANCH HERE 0 ,
6 : SWAP 2 [COMPILE] THEN 4 ; IMMEDIATE
7 : ENDCASE 4 ?PAIRS COMPILE DROP
8 BEGIN SP@ CSP @ = 0=
9 WHILE 2 [COMPILE] THEN
10 : REPEAT CSP 1 ; IMMEDIATE
11 : TEST CASE 41 OF . " A " ENDF
12 42 OF . " B " ENDF
13 65 OF . " C " ENDF EnDCase ;
14 ( 41 TEST A OK )
15

SCREEN # 144

0 ( OK, EAKER'S CASE CONSTRUCT WITH A SLIGHT MODIFICATION )
1 : CASE <OF CSP @ I CSP 4 ; IMMEDIATE
2 : OF 4 ?PAIRS COMPILE (OF) HERE 0 , 5 ; IMMEDIATE
3 : ENDF 5 ?PAIRS COMPILE BRANCH HERE 0 , SWAP 2
4 : IMMEDIATE
5 : ENDCASE 4 ?PAIRS COMPILE DROP BEGIN SP@ CSP @ = 0=
6 WHILE 2 [COMPILE] ENDIF REPEAT CSP 1 ; IMMEDIATE
7 : EnDCase ;
10
11
12
13
14
15 -->

SCREEN # 145

0 ( THE (OF, >OF, AND RAND-OF EXTENSIONS )
1 : OF 4 ?PAIRS COMPILE (OF) HERE 0 , 5 ; IMMEDIATE
2 : OF 4 ?PAIRS COMPILE (OF) HERE 0 , 5 ; IMMEDIATE
3 : ENDF 5 ?PAIRS COMPILE BRANCH HERE 0 , SWAP 2
4 : IMMEDIATE
5 : ENDCASE 4 ?PAIRS COMPILE DROP BEGIN SP@ CSP @ = 0=
6 WHILE 2 [COMPILE] ENDIF REPEAT CSP 1 ; IMMEDIATE
7 : RAND-OF 4 ?PAIRS COMPILE RANGE COMPILE BRANCH HERE 0 , 5 ; IMMEDIATE
10 IMMEDIATE
11
12
14
15 -->
Screen 147 illustrates a pre-Eaker solution to the design of an interactive terminal input that places a hexadecimal number on the stack, and which provides for error detection and error recovery. It is, of course written in my usual sloppy, unannotated, semi-readable fashion.

Screen 148 offers a neater solution in terms of \&OF and \>OF. It is definitely more readable. Screen 149 offers a still neater solution in terms of RNG-OF.

Screen 147 compiles to 160 bytes, screen 148 to 176 bytes, and screen 149 to 144 bytes. Need I say more?

SEND A CHECK TO FIG TODAY!
MAKE THIS YOUR BEGINNING!
RENEW NOW!
CASE as a Defining Word

Dan Lerner

After reading the CASE contest articles and looking for a simple function, I am compelled to submit a simple CASE statement. These words are fast to compile and execute, compact, simple, generate minimum code, and very simple. There is no error checking since the form is so simple the novice programmer can use it.

CASE is analogous to vectored GOTO in other languages. Its usage with my words is:

```
CASE NAME
A IS FUNCTION-A
B IS FUNCTION-B
C IS FUNCTION-C
(etc.)
OTHERS ERROR FUNCTION
```

General usage would be as a menu selector; for example, you print a menu:

1. BREAKFAST
2. LUNCH
3. DINNER

`SELECTION -->`

The user types a number which goes n the stack, then executes the CASE word MEAL. MEAL selects BREAKFAST, LUNCH or DINNER, or ABORTS on error. The source is:

```
CASE MEAL
1 IS BREAKFAST
2 IS LUNCH
3 IS DINNER
OTHERS NO MEAL
```

You have previously defined BREAKFAST, LUNCH, DINNER and NO MEAL.

How CASE is Structured

CASE builds an array using IS and OTHERS to fill and complete the values in the array. At execution, the `DOES` portion of CASE takes a value from the stack and looks through the array for it. A match executes the word, no match executes the word after OTHERS in source.

The form of CASE is a new class of words, as CONSTANT, VARIABLE, MSG, etc. are. The code executed to test the array is minimal.

```
106 0  CASE  NAME  PAIR  VALUE-PAIR
  1  A  IS  FUNCTION-A  ADDR  OF  FUNCTION-A
  2  B  IS  FUNCTION-B
  3  C  IS  FUNCTION-C
  4  ETC.
  5  OTHERS  ERRORFUNCTION

7  CASE CREATE HERE 0. , ( AT COMPIILATION BUILDS HEADER,LINK POINTS TO ADDR OF # OF PAIRS
  8  HERE SET TO ADDR OF VALUE-1 )
  9  DOES) ( AT EXECUTION, ADDR OF #OF PAIRS)
11  1 ROT ROT DUP 2+ SWAP @
12  0 DO 2DUP @ = IF DUP 2+ @ ( COMPARES INPUT VALUE
13  EXECUTE  ROT DROP 0 ROT ROT ( WITH VALUE A, B, C, ETC, AND)
14  LEAVE ELSE 2+ 2+ THEN LOOP ( EXECUTES ASSOCIATED FUNCTION )
15  ROT IF @ EXECUTE ELSE DROP THEN DROP ;
```

```
107 0  CASE WORDS)
  1  : IS , , 1+ ( HERE, PAIR# -- HERE, NEXT-PAIR# )
  2  : OTHERS , , SWAP ! ; ( HERE, #OF-PAIRS )
  3  4
  5  6
  7  8
  9  10
  11
  12
  13
  14
  15
```

THIS IS THE END!
THE END OF VOLUME III
THE END OF YOUR MEMBERSHIP?
DON'T LET IT HAPPEN!
RENEW TODAY!
Generalized CASE Structure in FORTH

E.H. Fey

Introduction

The CASE CONTEST held by FIG last year ended with some excellent contributions to the FORTH literature. The judges noted however that few people tried to devise a general case structure encompassing both the positional type, where the case is selected by an integer denoting its position in the list of cases (ala FORTRAN's computed GO TO), and the more general keyed type of structure, where the case selector key is tested for a match in the case words key list.

This article discusses a general case structure which combines the positional and keyed types. Like FORTH itself, the case structure is extensible. I have added a third type called range where the case selector key is tested to be within the range of pairs of values in the case words key list.

For any of the three types of structures, the user is also provided with the option of using headerless high level code sequences to specify the execution behavior of the individual cases.

A complete source listing in FIG-FORTH is given on screens 159 to 180 with illustrative examples on screens 180 and 181. The source code listings may seem lengthier than usual but it is the author's practice to include the Glossary definition right with the source and to annotate the source code with notes on the status of the parameter stack. When this practice is followed, I find FORTH to be an eminently readable language, even months after the particular coding has been prepared. However, this style of coding requires a good FORTH video editor. With a good case structure in FORTH, that is not difficult to develop.

Background

In the Aug. '80 issue of Byte, Kim Harris introduced a very simple positional type of case compiler. A slightly revised version of his compiler is:

```
CASE: xxxx cfal cfa2 ... cfan ;
to define a case selector word named xxxx.

When the new word, xxx, is executed in the form
k xxxx (k=1,...,n)
the k'th word in the list will be executed. For example, define the following words, COW, CHICK, PIG, and BARN:

: COW "MooOoOo" ;
: CHICK "Peep" ;
: PIG "Oink" ;
CASE: BARN COW PIG CHICK ;

If we now execute the sequence
BARN, Oink will be typed. Similarly 1 BARN will type MooOoOo.

Although there are no error checks, this case structure is easy to use, executes fast and requires a minimum of dictionary space for each case word, xxx. Bilobran, et al have used CASE: extensively in developing a FORTH file system with named record components (1980 FORML proc, pp 186, Nov. 1980). I have done likewise following their example.

The interesting part of the definition of CASE: is the \textless LIST part which I have called \textlangle LIST for obvious reasons. It creates the dictionary entry for xxxx, then, after executing SMUDGE and \textlangle CSP which are part of fig-FORTH's compiler security, it executes \textlangle DOES> which forces FORTH into the compilation state so that the user can enter the list. The list is terminated by \textgreater ; which completes the definition of xxxx.

For CASE: words, the list is a list of codes field addresses of previously defined FORTH words. Since FORTH is in the compilation state when the list is being entered, all the user has to do is list the names of the case select words (COW PIG CHICK in the example of BARN). FORTH then compiles their code field addresses, as long as they are not special IMMEDIATE words which execute during compilation.

Now suppose that we knew beforehand that the code field address of PIG was say 14382. The same definition of BARN could then have been achieved by

```
CASE: BARN COW [14382 , ] CHICK ;
```

where \texttt{[ stopped the compilation state, 14382 was entered to the stack, the word, (comma), compiled it and ] resumed the compilation state.}

The point is that \textlangle LIST is a powerful word for entering named lists and data of all sorts to the dictionary. The method of retrieval of the data is determined by the \texttt{DOES> part of the compiler. Hence if we simply change the definition of the \texttt{DOES> part of CASE:, we can transform it into a general purpose case compiler.}

The Multi-Purpose Case Compiler

The method utilized to develop a generalized case compiler is to compile a number for the case type as the first byte in the parameter field of xxxx. At execution time, the number is retrieved and used to select the appropriate \texttt{DOES>} part for the case type of xxxx. The type number is transparent to the user.

The definition of the new case compiler is:

```
: MCASE: \textless BUILDS SMUDGE \textlangle CSP HERE 1 C , 0 C , \rangle \textlangle DOES> DUP C@ DOESPART ;
```

where \texttt{DOESPART is a case selector word defined by CASE:}.

The \texttt{BUILDS} part of \texttt{MCASE:} compiles a \texttt{"1"} for the default case type of \texttt{position} and \texttt{"0"} for the count of the number of cases entered into the case list. It also leaves the parameter field address of the newly defined word on the stack so that it can be found later during the compilation process even though its name field is smudged.

If the newly defined case word, say xxxx, is to be other than the positional type, it is immediately followed by the word KEYED or RANGE to define the type of xxxx as keyed type = 3 or range type = 5.

```
: KEYED 3 OVER C@ IMMEDIATE : RANGE 5 OVER C@ IMMEDIATE
```

The case list subsequently entered must agree with the case type specified.

Two options are provided for the execution elements of the case list. The first or default option is the single word execution as in \texttt{CASE:}. The second option allows a headerless sequence of FORTH words to be defined as the execution elements of each case. The two may not be mixed.

A default case at the end of the case list is mandatory, although it may be a null word. The default case must be preceded by the word DEFAULT: whose definition is:

```
: DEFAULT: ?COMP EOL , HERE OVER C@ [DEF] ; IMMEDIATE
```

where \texttt{EOL is an end of list terminator constant defined by CFA CONSTANT EOL}
and [DEF] is a case selector word defined by CASE.

DEFAULT: first checks to see that you are in the compile state since you should be compiling xxxx. It then enters the end of list terminator, EOL, to the dictionary. Finally, it takes the parameter field address of xxxx left on the stack by the <BUILDS part of MCASE, gets the type of xxxx and executes the case selector word [DEF] depending on the type of xxxx.

If the type is 1, 3 or 5, [DEF] counts the number of cases entered and stores it in the second byte of the parameter field of xxxx. If the case type is 2, 4 or 6, then the execution elements are headerless code sequences. Hence for these types, [DEF] initiates the process of defining the default code sequence.

Execution of Case Selector

All case selector words, xxxx, defined by MCASE: are executed in the form:

k xxxx

where the key, k, is an integer. The interpretation of k in selecting the case depends on the case list type.

With three case list types and two options for each type, there are actually 6 different forms of case lists available. Let's consider first the lists with single word execution elements.

Single Word Execution Elements

1. Positional type

MCASE: is used in the form:

MCASE: xxxx cfal cfa2 ... cfan

DEFAULT: cfa;

When xxxx is executed in the form k xxxx, the case cfa will be selected if k is 1, 2, ..., n. Otherwise the default case, cfa, will be selected and executed.

2. Keyed type

MCASE: xxxx KEYED [ k1 , ] cfa1
[ k2 , ] cfa2
[ ... , ] cfan

DEFAULT: cfa;

When xxxx is later executed in the form k xxxx, the case cfa will be executed if a value of k is found in the list. Otherwise, the default case, cfa, will be executed.

( GENERAL CASE STRUCTURE

EXECUTION VARIABLES AND ARRAYS (See Ken Harris, Byte Aug '80)

( PP 184 also see R. A. McCourt, FD 11/4 PP 189, EHF 2/11/81 )

: IX ( k pfa ... cfad ) ( Computes addr of indx: k = 1+2*+n )
SWAP 1 MAX
1 - DUP + +

: LIST ( General (BUILDS word to construct named lists )

BUILDS SMUDGE (GSH)

: CFA @ CONSTANT COLOR ( For headerless code definitions )

: CFA @ CONSTANT EOL ( End of list delimiter )

: CASE: :LIST DOES: IX @ EXECUTE: ( Used in the form: CASE: xxxx cfal cfa2 ... cfan ; )

: XEVAR: :LIST DOES: IX @ EXECUTE: ( Used in the form: XEVAR: xxxx cfai ; )

: INSTALL ( ...cfa ) COMPILE: I STATE @ IF COMPILE CFA ELSE CFA

: INSTALL ( ...cfa ) COMPILE: I STATE @ IF COMPILE 2+ Compile: 2+ ! THEN: IMMEDIATE

: AT ( cfa ... ) COMPILE: I STATE @ IF COMPILE 2+ Compile: ELSE 2+ ! THEN: IMMEDIATE

: AT: IN ( k cfa pfa ... ) GET 1 MAX 2 + + i ( Stores cfa at )

: AT: IN ( k cfa ... ) COMPILE: I STATE @ IF COMPILE ( AT: IN )

: AT2 IN ( k cfa ... ) COMPILE: I STATE @ IF COMPILE ( AT: IN )

: DUM i --

( NOTE: McCourt's implementation of the function INSTALL ATIIN )

: CASE: : MCASE: : A GENERALIZED EXTENSION OF CASE:

1. Three types of case structures:
   A. POSITIONAL ( default )
   B. KEYED
   C. RANGE

2. Two structure options for each type:
   A. SINGLE WORD EXECUTION ( default )
   B. HIGH LEVEL HEADERLESS CODE SEQUENCE

( Define DOESPART and [DEF] as Execution arrays to be filled )

: CASE: : DOESPART DUM DUM DUM DUM DUM DUM DUM DUM

: CASE: [DEF] DUM DUM DUM DUM DUM DUM DUM DUM

: MCASE: ( The generalized case compiler )

BUILDS SMUDGE (CSP HERE ) ( Leave pfa on stack )
Range type

MCASE: xxxx RANGE
  [ L1, Hi, ] cfal
  [ L2, H2, ] cfal
  ...
  [ Ln, Hn, ] cfal
DEFAULT: cfad

For this type each of the n entries to the case list consists of a pair of values specifying the upper and lower limits of the range, Li and Hi, followed by the execution element, cfai.

When xxxx is later executed in the form k xxxx, the case cfai will be selected if the condition Li < k < Hi is found during a search of the list. If not, the default case, cfad, will be executed.

Headerless Code Execution Elements

Instead of specifying the execution elements as previously defined FORTH words, the elements may be specified as a sequence of FORTH words in the form:

H: ......seq...... ;H

where ......seq...... is the sequence of executable FORTH words.

Again we have the three applicable case list types, the default type, position, the keyed type and the range type. Examples of the structure of each of these types is

(1) Positional type

MCASE: xxxx
H: ......seq1...... ;H
H: ......seq2...... ;H
...
H: ......seqn...... ;H
DEFAULT: ......seqn......

(2) Keyed type

MCASE: xxxx KEYED
  [ k1, ] H: ......seq1...... ;H
  [ k2, ] H: ......seq2...... ;H
  ...
  [ kn, ] H: ......seqn...... ;H
DEFAULT: ......seqn......

Positional type with single word execution option: Type 1

1) EXECUTE

2) INSTALL PSEUDO ATNAT DOESPART

Positional type with high level def in list: Type 2

2) INSTALL PSEUDO ATNAT DOESPART

Positional type with high level def in list: Type 3

2) INSTALL PSEUDO ATNAT DOESPART
(5) Range type

MCASE: xxx RANGE
[ L1, H1, ] H2 ... seq... pH
[ L2, H2, ] H3 ... seq... pH
...
[ Ln, Hn, ] Hn ... seq... pH
DEFAULT: ... seq... pH

The interpretation of k in case selecting is the same as previously discussed for the single word execution of the same case type. The only difference is that a FORTH sequence, ... seq... is executed instead of a single FORTH word, cfa.

Examples

Examples of all 6 possible combinations of case structures are given on Screens 180 and 181. If the screen is loaded and examples tested, typical execution results should be:

EXECUTE RESULT TYPED
1 BARN MOO
2 BARN OINK
18 BARN PEEP (Default)
1 ZOO PEEP PEEP PEEP
2 ZOO PEEP PEEP MOO
-6 ZOO OINK OINK OINK

( Default)
1 FARM OINK (Default)
77 FARM MOO
-10 CASE MOO OINK PEEP
( Default)
77 CASE MOO ooOOO
-10 CORRAL PEEP PEEP
-1 CORRAL OINK OINK
309 CORRAL PEEP OINK MOO
310 CORRAL OINK MOO (Default)

COMMENTS

1. Kim Harris' case compiler, CASE: avoids the use of OVER = IF DROP ELSE THEN for every case as used in many of the other CASE constructs. The result is shorter compiled code in the application. The compiler, MCASE: presented here is an extension of CASE: and consequently shares this feature.

2. The compiler, CASE: and the Execution Array introduced by M.A. McCourt in FD II/6 pp 109 are functionally equivalent. Further, the Execution Variable, XEQVAR:, of McCourt turns out to be a degenerate case of CASE: with only one element in the case list. The definitions:

; XEQVAR CASE:;
; XEQVAR LIST DOES 0 EXECUTE ;

( KEYED TYPE WITH SINGLE WORD EXECUTION OPTION, TYPE 3 )

: KDEEF ( $fa addr... ) ( Counts # cases entered and stores
 in casecount at $fa+1. Address of default cfa is
 at $fa+4. )
OVER + - 4 / SWAP 14 C! 

: KSFIN ( K pfa... ) ( Searches type 3 list for match of kex )
( to $k. Starts at $fa+2. Executes cfa after matched )
( Key or default if no match found. )
24 BEGIN 1 $r+ DUP @ EOL -
( ... k addr f )
IF ( not EOL ) OVER OVER @ =
( ... k addr f 
OVER @ = ( ... k addr f
ELSE R1 - @ Rx 4 + THEN
( ... k addr f
ELSE ( EOL ) 24
( ... k addr def
THEN Rx
( ... k addr new f
UNTIL ( EOL or EOL ) SWAP DROP @ EXECUTE ;

3 INSTALL KSFIN ATINON DOES 3
3 INSTALL KDEEF ATINON DEFP

( KEYED OPTION WITH HIGH LEVEL DEF IN LIST, TYPE 4 )

: KMFINF ( K pfa... ) ( Searches type 4 list for match of kex )
( to $k. Starts at $fa+2. Executes high level sequence )
( following match or default sequence if no match found. )
24 BEGIN 1 $r+ DUP @ EOL -
( ... k addr f
IF ( not EOL ) OVER OVER @ =
( ... k addr f
OVER @ = ( ... k addr f
IF ( matches ) 4 +
( ... k addr 14
ELSE Rx - @ Rx 4 + THEN
( ... k addr f
ELSE ( EOL ) 24
( ... k addr def
THEN Rx
( ... k addr new f
UNTIL ( EOL or EOL ) SWAP DROP @ EXECUTE ;

4 INSTALL KMFINF ATINON DOES 4
4 INSTALL KDEEF ATINON DEFP ( Same as type 2 )

( RANGE TYPE WITH SINGLE WORD EXECUTION OPTION, TYPE 5 )

: RDSDEF ( pfa addr... ) ( addr def= $fa+4:8:1-14: Compute n and
store at $fa+1 )
OVER + - 4 / SWAP 14 C! 

: RANG ( K addr f ) ( True if K= value at addr AND K= value
at addr+2 )
DUP @ < SWAP Rx 24 @ OR 0= 

: RDSFIND ( K pfa... ) ( Searches type 5 list for first occurrence
of K within pair of range values. Executes cfa following
the pair. Executes default cfa if not found )
24 BEGIN 1 $r+ DUP @ EOL -
( ... k addr f
IF ( not EOL ) OVER OVER RANG?
( ... k addr f
IF ( in range )
ELSE Rx 1 - @ Rx 4 + THEN
( ... k addr f
ELSE ( EOL ) 24
( ... k addr def
THEN Rx
( ... k addr new f
UNTIL ( In range or EOL ) SWAP DROP @ EXECUTE ;

5 INSTALL RDSFIND ATINON DOES 5
5 INSTALL RDSDEF ATINON DEFP

( RANGE OPTION WITH HIGH LEVEL DEF IN LIST, TYPE 6 )

: RHFIND ( K pfa... ) ( Searches type 6 list for first occurrence
of K within pair of range values. If found, executes
following high level sequence; else executes def sequence )
24 BEGIN 1 $r+ DUP @ EOL -
( ... k addr f
IF ( not EOL ) OVER OVER RANG?
( ... k addr f
IF ( in range )
ELSE Rx 1 - @ Rx 4 + THEN
( ... k addr f
ELSE ( EOL ) 24
( ... k addr def

Page 193
are fig-FORTH functional equivalents of McCourt's definitions. Hence CASE; can be used as an Execution Array as suggested by McCourt. The definitions of AT, ATKIN and INSTALL on screens 167 and 168 can be used as McCourt to change the elements in CASE: list words. They are used in the form

K INSTALL yyyy ATKIN xxxx

to change the k'th element in a case list, xxxx defined by CASE:; to the code field address of yyyy. Now whenever k xxxx is encountered, the word yyyy will be executed rather than the original word in the k'th position of the case list.

Using the previous CASE: example of BARN, if we execute

2 INSTALL COW ATKIN BARN

the second case in BARN will be changed from PIG to COW. Later execution of BARN anywhere in the program will then type MCASH instead of Oink.

Although this is non-structured programming, it is still a valuable programming tool when used properly. The present definitions of INSTALL and ATKIN can be used within a colon definition.

Please note that the use of the Execution Array in the development of MCASE: on screen 169 is purely stylistic. It is not a necessary feature of the development.

3. The essentially unique feature of FORTH in that it is extendable by the user. With an expanding FORTH literature, it is clear to this author that FORTH will improve with time faster than all other languages and that there is no upper limit to its improvement. It has been less than 18 months since I first got FORTH up and running. In that short period of time, thanks to the fig literature, the FORTH system I have running now is, in my opinion, vastly superior to any other language I have ever seen. And it will get better!
A FORTH Standards Team meeting will be held in Bethesda, MD, from May 11 through May 14. The meeting is open to the current Standards Team members and a limited number of observers. The site will be the National 4H Center, a self-contained educational facility, just outside Washington, DC. The campus-like Center has meeting rooms, dining facilities and dormitory accommodations.

This four-day meeting will allow world-wide Team members to consider proposals and corrections for the current FORTH Standard and develop future standards policy. Participation is possible by submittal and attendance. Written submittals received by April 30 will be distributed to attendees before the meeting. Late receipts will be distributed at the team meeting. Those wishing to attend must apply without delay, as space is severely limited.

Applicants (other than team members) must submit a biography by April 15 for consideration by the credentials committee. You should include

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Accommodations are $41 to $47 per day, per person, including meals. Send a refundable $100 deposit (and biography for observers) to the meeting coordinator. You will receive further details on choices in housing and meals.

Submittals are essential if Team actions are to represent the broadening scope of FORTH users. Specific consideration will be given to an addendum correcting FORTH-79, the Team Charter, and alliance with other standards groups. Those not attending may receive copies of submittals by sending $30 to the meeting coordinator.

All submittals and reservations should be directed to the meeting coordinator:
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