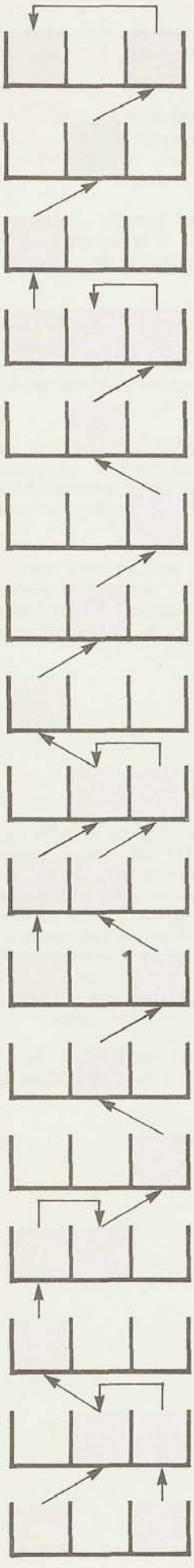

FORTH DIMENSIONS

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INSIDE

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 fo 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 2,400 worldwide. It was formed in 1978 by FORTH programmers to encourage use of the language by the interchange of ideas through seminars and publications.

EDITOR'S COLUMN

1981 is behind us and as I look back, I am pleased to see how much has been accomplished for FORTH, FIG and FORTH DIMENSIONS.

I really appreciate all the help and support I have received from our readers. I have not done everything right and some of the best help has been your disagreement. Intelligent, constructive criticism is as welcome as earned praise.

1982 will be a year of continued growth. You can look forward to continuing responsiveness. It is my plan to contact every FIG chapter by telephone at least quarterly to get feedback and encourage reader contributions.

FORTH DIMENSIONS will also be awarding AUTHOR'S CERTIFICATES for outstanding articles that contribute to the growth and understanding of the language. While we are not yet in a position to give you cash for your contributions, we at least will give you credit.

Starting in this issue will be a policy of putting in tutorial articles designed to help our entry level readers. This, however, will not be done at the expense of our more seasoned FIGGERS who will find an expanded base of challenging articles and applications.

In closing, I want to say that the writer's kits have finally come off the presses and I will be glad to send one to anyone who wants to contribute. Please send in applications and utilities, philosophy, questions and problems -- in the final analysis, FORTH DIMENSIONS is what you make it.

C. J. Street

PUBLISHER'S COLUMN

1981 has been a great year for FORTH, the FORTH Interest Group and for me, personally. FORTH has spread around the world and is being used on thousands of computer and microprocessor-based products. It is being taught extensively in schools, companies and by FORTH programmers. FIG has just completed its most successful national convention with almost 500 attendees, over 20 exhibitors and multiple sessions. (Thanks to Bob Reiling, Conference Chairman and Gary Feterbach, Program Chairman.) The FORML conference was well attended and the Proceedings are now available--see order form.

My deepest thanks to the FORTH community for "THE FIGGY", Man of Year Award. It was a fantastic thrill and a surprise. I stand in good company.

Roy C. Martens

LETTERS TO THE EDITORS

Dear Fig:

I have developed a process-simulation program that occupies very little memory space and yet has many of the capabilities of commercial simulation packages.

I have been heavily involved in modeling and simulation of automated manufacturing systems for over six years. My ultimate objective for this work is to develop a microprocessor-based simulation capability which incorporates process control structures far beyond those of currently available languages. However, the relatively extensive modeling power of the current code would seem to offer interesting market potential in its own right.

If you can provide information on marketing such a product, please contact me by mail or by phone (home (317) 447-9206, office (317) 749-2946).

Joseph Talavage, Ph.D.
3907 Prange Dr.
Lafayette, IN 47905

Hope printing your letter helps.--ed.

Dear Fig:

I am puzzled as to why I have not seen mention in your New Products announcements of fullFORTH+ for PET, available also, I believe for Apple. It is published by IDPC, Co., PO Box 11594, Bethlehem Pike, Colmar, PA 18915 at $65. It is advertised as "A full-featured FORTH with extensions conforming to Forth Interest Group standards. Includes assembler, string processing capabilities, disk virtual memory, multiple dimensioned arrays, floating point and integer processing." Surely, fullFORTH+ is worth a mention, if not a comprehensive review!

Francis T. Chambers
ROCK HOUSE
Ballyoroy, Westport
Co. Mayo, Ireland

Thank you for your interest. This was reviewed in Vol. III, #3.--ed.

Dear Fig:

This is our response to Chuck's (Moore's) cute letter.

Arthur Goldberg
Spencer SooHoo
CEDARS SINAI MEDICAL CTR.
9700 Beverly Blvd.
Los Angeles, CA 90048

DEA- CHU--

WE CHA------ YOU TO CON----- THE CON----- OF THI- CON------ LET---. WE CLA-- THA- THE CON---- OF A WOR- IN COM--- ENG---- CON-------- CON-------- - TO OUR ABI---- TO DEC----- IT FRO-THR-- LET---- AND THE LEN---.

HOW----, IN COM----- PRO----- THE CON---- IS LES- CON------ (COM-----, WOR-- CAN BE SWA---- WIT---- CHA---- - THE SEM------). CON--------- IT CON-------- CON--------- LES- HEL- IN IDE---------- THE DEF------- OF A WOR-. IN FAC-, AS THI- LET--- DEM---------, THR--LET---- AND A LEN--- CAN LET----EVE- A CAR---- REA--- OF COM---ENG----.

SIN------ YOU--,
ART--- GOL-----
SPE---- SOO---

(TRANSLATION)

Dear Chuck:

WE CHALLENGE YOU TO CONSIDER THE CONTENTS OF THIS CONFUSING LETTER. WE CLAIM THAT THE CONTEXT OF A WORD IN COMMON ENGLISH CONTRIBUTES CONSIDERABLY TO OUR ABILITY TO DECIPHER IT FROM THREE LETTERS AND THE LENGTH.

HOWEVER, IN COMPUTER PROGRAMS THE CONTEXT IS LESS CONFINING (COMMONLY, WORDS CAN BE SWAPPED WITHOUT CHANGING THE SEMANTICS). CONSEQUENTLY IT CONTRIBUTES CONSIDERABLY LESS HELP IN IDENTIFYING THE DEFINITION OF A WORD. IN FACT, AS THIS LETTER DEMONSTRATES, THREE LETTERS AND A LENGTH CAN LETDOWN EVEN A CAREFUL READER OF COMMON ENGLISH.

SINCERELY YOURS,
ARTHUR GOLDBERG
SPENCER SOOHOO

Your letter and its "translation" certainly make the point!--ed.

Dear Fig:

Right now I am trying to put together a local Danish FIG, and I would therefore like you to update me with the names and addresses of the Danish FIG members and possible make a note in FORTH DIMENSIONS about my intentions.

As the communication lines are rather long and since our magazine is only bi-monthly, please inform me on your next deadline as soon as possible.

Niels Oesten
Brostykkevej 189
DK-2650 Hvidovre
Denmark

Thanks Niels. Good luck on establishing a local Danish FIG Group. Anyone interested, please contact Niels as listed above. Regarding deadlines: Copy must be in our hands 6 weeks prior to publication, i.e., 4/15 is the deadline for May/June edition, etc.--ed.

Dear Fig:

I just wanted to write to tell you how much I enjoy FORTH DIMENSIONS. Every issue has several things of interest to me, and I appreciate your work in seeing that it gets done (often a thankless task). Here in New Hampshire, Rob Moore of SNAC (Southern New-Hampshire Apple Corps) is doing most of the work in implementing and refining a version of fig-FORTH for the Apple II. We have taken as much as possible from page zero so that we can use the many subroutines available from the Applesoft ROM. I have been working with our version for some time now and am doing a high-resolution graphics game using FORTH and Applesoft hi-res routines.

Gregg Williams
BYTE Publications
PO Box 372
Hancock, NH 03449

Thanks Gregg. Glad you enjoy and appreciate our efforts.--ed.

Dear Fig:

Regarding the 8080 Renovation Project's requests for bug fixes, I would like to counter with a request that they provide a status report in FORTH DIMENSIONS that includes those bugs already reported along with any solutions proposed or implemented. It would also be of interest to find out what the goals are for the 8080 Renovation Project and how local FIG chapters can help.

There is what I consider a bug in that the message routine uses an absolute value of screen 4 and 5 for getting error message information. This is fine where offset is zero but when an offset other than zero is used and the disk has other information on absolute screens 4 and 5, things don't look too good.

Robert I. Demrow
P. O. Box 158 BluSta
Andover, MA 01810

Thanks for the input. Your request has

been forwarded to the 8080 Renovation Project people as well as printed here.

--ed.

Dear Fig:

After receiving my installation guide, I spent a week keying in the requisite seventy-five pages of 6502 assembler code. Now, I am a confirmed figger. I have written my own 6502 FORTH assembler, a small wordprocessor (with which I am writing this letter), and an APPLE II graphics utility resembling LOGO. I like FORTH!

Bob Wiseman
118 St. Andrews Drive
Cincinnati, OH 45245

Your last name says it all! How about some articles for FD-publication?--ed.

Dear Fig:

I am spreading the FORTH gospel here in Taiwan. I have written about 20 lectures and numerous demonstrations to various universities and institutions in this area and have generated quite a bit of local interest.

From ground zero, I can now count about 10 FORTH systems installed already. Many of them, from the FIG Installation Manual and source listing, I brought with me.

An informal FORTH discussion group has already been formed, and our last meeting on October 25th attracted 20 enthusiasts. I am having fun too!

My home phone in Taipei is 393-1554. If any of you happen to be heading this way, be sure to let me know.

Dr. Chen-hanson Ting
National Yang Ming Medical College
Taipei, Taiwan, 112 R.O.C.
(02) 831-2301

Glad to hear you are doing so well. We all miss you here.--ed.

Dear Fig:

I want to extend my apologies to you, your readers and the FORTH Interest Group. I sent in an announcement about FORTH ROMS for the TRS-80, MOD I several months ago. Unfortunately, circumstances beyond my control now force me to revise their avabilability schedule. I will spare everyone further embarrassment by waiting to send in another announcement until I have the first chip set in hand.

Martin Schaaf
P. O. Box 1001
Daly City, CA 94017

Thanks for the update, Martin. This points up why we have our policy of not announcing unreleased products.--ed.

Dear Fig:

In the packet of materials I got when I joined FIG was a copy of FORTH DIMENSIONS, Volume III, #1 with a product review of Timin-FORTH. The review interested me in two respects. One was the benchmark tests that it contained; the other were the comments on the alleged lack of superiority of the Z-80 compared to the 8080.

Those benchmarks gave me a chance to compare my machine with my version of FORTH--the results of which surprised me since my machine only runs at 2 mhz and the machine used in the review runs at 6 mhz. I expected my machine would take three times longer but in all tests, it ran comparable or even faster. It would seem my implementation is faster for involved arithmetic operations.

The editors of FORTH DIMENSIONS are right, I believe, in being wary of timing benchmarks for it is easy to draw invalid conclusions from them. In fact, the editors themselves drew the wrong conclusions!

The tests do not show the Z-80 runs benchmarks slower than the 8080--the Z-80 was used for both tests. The correct conclusion is that some FORTH implementations are more efficient than others and that some versions on the market are terribly slow.

I am sure you get a flood of letters following a benchmark; but I just had to write to say that the speed of FORTH is not necessarily just a function of processor speed as you have often claimed.

Everett Carter
Harvard University
Division of Applied Sciences
Cambridge, MA 02138

Thank you for your well thought out contribution.--ed.

Dear Fig:

A comment about your publication FORTH DIMENSIONS. The information is certainly useful (especially the applications), however, much of the material assumes a complete understanding of FORTH'S inner workings. I don't really understand how the compiler works and what all those cryptic words (CFA, PFA, SMUDGE, IMMEDIATE, etc.) do, but I would like to learn. I am sure there are others out there like me, so how about some tutorial articles on some of these FORTH-unique features.

Thomas Kastner
7918 207th St. SE
Snohomish, WA 98290

Entry-level tutorial articles are an area I have been exploring for the past year. Check this issue and you will find the first in a series of articles contributed by Henry Laxen of LAXEN AND HARRIS, INC., a firm that specializes in FORTH instruction.--ed.

Dear Fig:

I don't doubt FORTH would be more useful if my machine had all of the features described in "An Open Response" (Volume II, #6) but consider what I have gained without them:

1. An understanding of how FORTH works.

2. A demonstration that a workable subset of FORTH can be implemented on a very small system.

3. Hours of enjoyment and appreciation of FORTH's virtues.

4. A useable language faster and better than Tiny Basic and more convenient than machine language.

5. The ability to install and interactively test a larger version of FORTH when I expand my machine.

I feel the article does users of small systems a disservice. Instead of discouraging users of small systems, FIG should encourage development of standardized subsets for use on small machines.

Roger L. Cole
395 Elm Park Avenue
Elmhurst, IL 60126

FORTH DIMENSIONS publishes articles to encourage communications, thought and growth of the FORTH world. Far from discouraging users of small systems, the FIG leadership is composed almost exclusively of members with small systems. FIG has been a leader in encouraging the development and use of FORTH on small systems. In fact, it is probably safe to say that if there were no FIG, there would be no FORTH, for small users today. Most of the vendors and systems now in use have been derived from FIG listings provided at cost. The source data for these listings, FORML research, standards, etc., which so many take for granted, have been derived from the labor and cash contribu-

tions of volunteers serving without reimbursement. The FORTH DIMENSIONS editorial staff supports FIG efforts to keep FORTH intact and resist the temptation to obtain mere popularity and in the process, fail in their mission to provide and support the finest software concepts and tools available today. This has not been an easy task (and all too often, a thankless one) but it is hoped that if others will least try to understand, the efforts and contributions of these volunteers will continue to benefit us all.--ed.

Dear Fig:

Congratulations to all the people who produce FORTH DIMENSIONS on its quality and improvement. Please send me a writer's kit so I can make some of my applications presentable for publication.

Bob Royce
Box 57 Michiana
New Buffalo, MI 49117

Your kit is on the way! Anyone else?

--ed.

Dear Fig:

Glen Haydon's nice article in FORTH DIMENSIONS III/2, page 47 talks about an algorithm he would like to have to determine the Julian day. With the background that FORTH has in astronomy, I'm sure there must be several, but this is the nicest I know. It comes from the U. S. Naval Observatory via an article in the Astrophysical Journal Supplement Series, Vol. 41 No. 3 Nov. 1979 pp 391-2.

```
0   ( JULIAN DATE )
1   : JD >R SWAP
2     DUP 9 + 12 / R + 7 * 4 / MINUS
3     OVER 9 - 7 / R + 100 / 1+ 3 * 4 / -
4     SWAP 275 9 */ +
5     + S-> D 1.721029 D+
6     367 R> M* D+ ;
```

Example: 3 20 1982 JD D.
2445049 OK

If you are only concerned with dates between 3/1/1900 and 2/28/2000, then you can omit line 3 entirely.

On another subject, there is another correction I noticed in the dump of the fig-FORTH 6502 Assembly Source - at location OC32, 80 1A should be D7 OB.

Peter B. Dunckel
52 Seventh Avenue
San Francisco, CA 94118

Really slick! But the algorithm would be hard to explain to most people.--ed.

FUNCTIONAL PROGRAMMING AND FORTH

Harvey Glass
University of South Florida
College of Engineering
Department of Computer Science
Tampa, FL 33620

The distinguished computer scientist, John Backus, in his 1977 Turing Award lecture (1) describes the shortcomings of conventional programming languages and suggests a new approach to programming in a style described as functional programming (FP). We will summarize the faults that Backus finds in conventional languages, briefly describe the functional programming style, and lastly show that FORTH meets the spirit of this style of programming.

Conventional Languages

An underlying problem of conventional programming languages is that they tend to be high level descriptions of the Von Neumann computer. The assignment statement is the principal construct of these languages. A program becomes a series of these assignment statements, each of which requires the modification of a single cell. We may think of the Von Neumann computer as a set of storage cells, a separate processor, and a channel connecting the two. If assignment statements imitate the store operation, then branch statements imitate jump and test while variables imitate storage cells. The high level languages provide sophisticated constructs to directly model the underlying Von Neumann design. Conventional languages in the "word at a time" flow described above require large data transfers through this small channel connecting main storage and the CPU. Backus calls this the Von Neumann bottleneck. It is not merely a physical bottleneck but, more importantly, it is a bottleneck to our thinking about computer languages. Backus refers to it as an "intellectual bottleneck." He characterizes conventional languages as both fat and weak since increases in the size and complexity of these languages have provided only small increases in power. The typical programming language requires a large fixed set of constructs, is inflexible, and is not extensible. The problem has been eased by approaches such as top-down design and structured programming, but these have not provided a solution to the underlying difficulty. Backus suggests that we need a new way of thinking about computing. He describes a new style which he calls functional programming.

Functional Programming

This new style of programming has the following characteristics:

- A function (program) is constructed from a set of previously defined functions using a set of functional forms that combine these existing functions to form new ones.

- The most fundamental functional form is called composition. If the composition operator is denoted by o, then in Backus' notation "fog" is the function where g is first applied and then f.

- The functions incorporate no data and do not name their conventions nor substitution rules.

- A function is hierarchical; i.e., built from simpler functions.

Backus points out that, "FP (Functional Programming) systems are so minimal that some readers may find it difficult to view them as programming languages." We have a set of predefined functions in a library (dictionary) and may define new functions in terms of these predefined functions.

Functional forms are constructs denoting functions which take functions as parameters. For example, the construct "if-else-then", and the construct "do while" are functional forms. As indicated above, composition is also a functional form.

FORTH of course has predefined constructs which serve as the functional forms of FP systems. In fact, FORTH provides facilities for adding new functional forms. An example would be a "case" construct to provide a more flexible and clear decision structure than that of a set of nested "if-else-then"s. The capability of language to add new functional forms is not inherent in FP systems. Backus defines a language with this capability as a formal functional programming (FFP) language.

An Example of Functional Programming: The Factorial Function

An example of a program written in the style of functional programming is as follows:

def !! ≡ eq0 → $\overline{1}$; * o [id , !! sub1], where the notation o, ≡, and [ ] denote functional forms. As we have seen, o denotes composition. The notation $[f_1,f_2]$ denotes construction where $[f_1,f_2]$ applied to an argument x yields the sequence $\langle f_1(x), f_2(x)\rangle$. The notation p → f;g applied to an argument x indicates that the value p(x) is to be examined and if p(x) is true the expression yields f(x) else it yields g(x).

Other definitions used in the above are:

eq0 applied to x yields a value true if x is 0, and yields false otherwise.

$\overline{1}$ is the literal value 1 and yields the

value 1, regardless of the argument.

* is the multiplication operator, and applied to a sequence <x,y> yields x*y.

id is the identity operator. id applied to x yields x.

sub1 applied to an argument x yields x-1.

Following the logic of the above function we see that !! applied to an argument n yields 1 if n is zero. If n is not zero we generate n*(n-1)!

Clearly then for n≥0 this is a definition of the factorial function. In FORTH (if the language were recursive) we would write:

```
: !!
  DUP 0= IF 1+
       ELSE DUP 1 - !! *
       THEN ;
```

The syntaxes of the two examples are different. The composition rule is applied right to left in the first example and left to right in FORTH. The rules for dropping arguments are different. Construction is not used in FORTH.* That the rules of syntax are different should not be surprising. The operations were defined by different people at different times. What is most important is that on close examination it is apparent that the style is essentially the same. We have "words" which denote functions which are evaluated following very similar rules.

FORTH as a Language with Characteristics of Functional Programming

Consider the FORTH (outer) interpreter. Literally all that the interpreter recognizes are functions; or to be precise, words that denote functions.** The fundamental combining form is composition where in FORTH "fog" would be expressed as g f. Functions need not incorporate data, do not name their arguments, and require no substitution rules for parameter passing. There are no assignment statements and a new function is built from simpler previously defined functions. It is this style of programming in FORTH--so different than that of conventional languages--that provides a power and flexibility that has sparked the enthusiasm of so many of us.

Summary

This very short summary of the article by John Backus does not begin to do justice to either the scope or depth of the paper.

The "new" type of programming has generated considerable interest within the computing community and most particularly among those interested in innovative approaches to computer architectures. It is this author's contention that FORTH is a functional programming language which closely resembles the approach suggested by John Backus in his definitive paper. It will be interesting to see if, as a result of this paper, languages which have attributes similar to FORTH begin to appear in academic circles.

---

* The author has recently implemented such an operator in FORTH.

** The way that literals are handled can be viewed as merely a question of implementation and efficiency.

References

1. J. Backus, "Can Programming be Liberated from the Von Neumann Style?" CACM, Vol. 21, No. 8, August 1978, p. 613.

FORTH AND ARTIFICIAL LINGUISTICS

Raymond Weisling
Surakarta, Jawa Tengah
Republik Indonesia

There has not been much said about the linguistic nature of computer languages, principally because so few of them permit the development of syntax structures that apporach human language, and hence foster linguistic observation. FORTH and its other threaded-code relatives allow for such structures to be developed, principally because of the larger body of words that arise from its extensibility and hierarchal function of operators.

The point I wish to address here is the syntactical limitations of the language we are building, an artificial language based in part on a human language (English) that is widely used wherever technology has developed. But there is a fundamental weakness in this English which I think we must be aware of, since it runs counter to the philosophy of FORTH. This is the syntax-sensitivity of word forms, especially nouns and verbs, which in English are commonly spelled and pronounced exactly the same. We rely on the structure (word-order, partly) to distinguish these often unrelated words.

A few examples are in order. Consider the possible function of these FORTH words, both with respect to their current use (some are nouns while others are verbs), but also in their opposite hypothetical use: BUFFER , FENCE , KEY , LIMIT , LOOP , SPACE , TYPE , etc. Others which a programmer might wish to use in developing applications might include: OFFSET , SPAN , INSERT , FILE , CATALOG , OUTPUT . Since the action of these words is not known from the word itself, but only from either previous agreement or syntax, and since syntax sensitivity is not a common part of FORTH (i.e., where a syntactical form does not alter the way in which a word is compiled), some degree of confusion can result.

Furthermore, use of a word in only one form rules out its use in another form, except where it can reside in a different vocabulary. Thus words like KEY , LOOP , BLANK , and TYPE (all FORTH verbs) cannot function as nouns despite our temptation to use them that way for their inherent (English language-based) clarity. The same is true of some of the FORTH nouns like BLOCK , BUFFER , STATE , LIMIT , and BASE .

Thus it is not possible to know the nature of the word from its name alone. Would prefixes for verbs unnecessarily clutter the language? Would some prefix or suffix to differentiate constants from variables be useful? Or should we leave it alone. The TO and FROM words help clarify things but are not without problems, whereas ! and @ are perfectly uniform in function. Could a FORTH-like language be built that allows the word-type to become part of the header, with the compiler choosing which form of the same-named word to use based on its syntactical position, like nouns (variables, constants, arrays) being objects of TO and FROM ? Or does this push us back into the horrible mess of artificial syntax forms such as algebraic notation (something we are perhaps proud to have departed from)?

I offer no solution per se. I only wish to point out a weakness that we all should be sensitive to when we assign names to our words. Since FORTH is still in evolution, this is yet another aspect to consider when standards are defined. I wish to disclaim any implication that I am a linguist of any sort other than Armchair Linguist. My sensitivity to this is a result of living in a different culture where I am learning a human language that permits far greater fluidity of structure due to the inherent differences in nouns and verbs, shown by a well codified system of prefixes and suffixes (morphemological differentiators). Those here who learn English struggle with the structural differentiation of all the parts of speech while our morpheme differentiators are used for relatively useless things like verb conjugation, plurality, cases, and tenses (which are all essentially absent in this part of the world). As technology spreads, an artificial language for man-machine manipulation (a two way street) should be more universally based, at least with respect to linguistic modeling. As FORTH is already in use in many parts of the world, the channel for feedback is already open.

FORTH STANDARDS CORNER

Robert L. Smith

More Words on WORD

In my last column, I discussed WORD. I neglected to mention an important topic relating to the implementations of WORD which may influence transportability. Prior to the 79-Standard, the execution of WORD caused the string from the input medium to be moved to the dictionary area, starting at HERE with the character count. Some implementers would be tempted to define the 79-Standard WORD from the older WORD in a manner somewhat like this:

```
: WORD  WORD HERE ;
```

Other implementers would probably put the string elsewhere. Now suppose that the user wished to reverse the character string and emplace the modified string in the dictionary. The result from the former implementer's system will not be as expected, and will not result in "equivalent execution" on the later implementer's system. A similar but much less serious problem occurs with PAD. PAD is conventionally offset from HERE by a fixed amount (68 bytes in fig-FORTH). There are at least three different solutions:

(1) Implementations which place the string at HERE could be considered non-standard, and the problem goes away.

(2) A clarification could be added to the Standard indicating either that the string will always be at HERE, or that it may be at HERE.

(3) The problem could be forced upon users by requiring that the characters from WORD be stored in a user-defined area prior to their movement to the final destination.

Let Me Number the Ways

In many areas the 79-Standard defines limits and formats in painful detail. There is an important area in which very little is said, namely the format for single and double precision numbers in the input stream. In the section "interpreter, text" it is clear that "numbers" are allowed in the input text stream and may either be compiled or placed on the parameter stack. A definition of the format of a number should include at a minimum the distinction between double and single precision, the sign of the number, and the set of allowed characters from which the number is constructed. In keeping with the spirit of the rest of the Standard, I would like to propose a few definitions which should be fairly easy to implement and which appear to be compatible with most current implementations (including fig-FORTH). First, we define a digit:

digit

A digit is any one of a set of ASCII characters which represent numeric values in the range from 0 to base-1. For bases greater than decimal 10, the set of characters is 0 ... 9 A B C ... where the ascending ASCII sequence is used for A and above.

Next, we add to the original definition of number as follows:

number

A number is represented in the input stream as a word composed of a sequence of one or more digits with a leading ASCII minus (-) if the number is negative and a trailing ASCII dot (.) if the value is to be considered double precision.

I recommend that implementers allow the above format, and that authors of transportable programs adhere to the same format. In any case, when the Standards Team meets again, they should certainly clarify this area.

Under the Spreading FIG-TREE

As many of you are aware, there is a Computer Conference Tree (now nicknamed the FIG-TREE) which contains items of interest to the FORTH community. I would like to encourage all persons interested in the 79-Standard to read and contribute to the branch of the FIG-TREE called 79-STANDARD. All you need is a terminal (110 or 300 baud), a modem, and a telephone. The number is (415) 538-3580. See back issues of FORTH DIMENSIONS for further information, or just call up and send a few carriage returns until the system responds.

CORRECTIONS

Add to: FD III/4, pg. 102 the following:

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1. Forsley, Lawrence P. The Beta Laser Control System. A talk given at the Laboratory for Laser Energetics on March 9, 1977 and on July 16, 1977 at the Wilson Synchrotron, Cornell University.

2. Forsley, Lawrence P. "Forth Multitasking in URTH". The Best of the Computer Faires Volume IV. San Francisco: 1979.

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4. ------. Towards More Usable Systems: The LSRAD Report. (Large Systems Requirements for Application Development). Chicago: Share, Inc., 1979.

5. ------. IEEE Standard 583-1975. New York: IEEE, 1975.

6. ------. 1977 Laboratory for Laser Energetics Annual Report. Rochester, NY: Laboratory for Laser Energetics, 1978.

7. Moore, Charles. "Forth: A New Way to Program Minicoimputers" Journal of Astronomy and Astrophysics Supplement 15. New York: AAAS, September, 1974.

8. Moore, Charles. "Forth, The Past Ten Years and the Next Two Weeks". Forth Dimensions. Vol. 16 San Carlos, CA: Forth Interest Group, 1979.

9. Rather, Elizabeth and Charles Moore. "The FORTH Approach to Operating Systems". ACM '76 Proceedings. New York: ACM, October, 1976.

10. Ritchie, D. M. and K. Thompson. "The UNIX Time-Sharing System". The Bell System Technical Journal. Vol. 57 No. 6 Part 2. New Providence, NJ: A.T. and T., July-August, 1978.

11. Ritchie, D. M., et al. "The C Programming Language". The Bell System Technical Journal. Vol 57 No. 6 Part 2. New Providence, NJ: A.T. and T., July-August, 1978.

Change: FDIII/4, pg. 118, para 3 to:

The TO concept was developed by Dr. Paul Bartholdi[2] as an alternative to constants and variables.

EDITOR'S NOTE:

Peter Bengtson of DATATRONIC AB in Stockholm, Sweden sent us a copy of the September, 1981 edition of Electronics And Computing Monthly. Feature article was FORTH, "The Language of the Eighties" in which FIG is mentioned prominently. More confirmation we are all riding the crest!

TECHNOTES, BUGS AND FIXES

I have three questions about FORTH:

Q. I know of two CP/M FORTHs that have their own way of dealing with the BIOS and BDOS and as a result cannot read each other's screens. What I'm leading to is this: CP/M and fig-FORTH are both supposed to be machine independent systems but cannot read each other's source code files. CP/M figgers ought to get together on this one.

A. Differences between disk organizations are sector skewing and location. It is easy to add definitions to a FORTH which uses BIOS so it can read other organizations; it is not possible the other direction.

2. When selecting a new drive, you need to do a COLD start or you'll remain on the last drive--this is only true if you are accessing the same screen number. If you leave an empty line between two definitions on the screen, a LOAD will stop loading at the empty line. Are these FORTH conventions I haven't heard about yet or are they peculiar to my Timin FORTH?

A. Both of these are bugs--demand fixes from Timin.

3. Somehow(?), I've been leaving a lot of control characters behind when using the editor. They don't show up on a screen list but they sure ruin any attempt at loading the screen. I am not sure if this is a common problem but I have enclosed a short routine to replace control charaters with spaces for anyone else who has this problem.

```
SCREEN: 95
( HUNT FOR CONTROL CHARACTERS)
: HUNT  ( SCREEN # --- )
        BLOCK
        1024 0 DO DUP C@ DUP 32 <
           IF  CR ."↑" 64 + EMIT
        ."  @ :" DUP U. ELSE DROP
           ENDIF 1+ LOOP DROP ;
: FIXSCREEN ( SCREEN # --- )
        BLOCK
        1024 0 DO DUP C@ 32 < IF
           DUP 32 SWAP C! ENDIF
        1+ LOOP DROP ;
( ACTUALLY HUNT AND FIXSCREEN
   ARE QUITE SIMILAR, HUNT JUST
SHOWS UP ANY GUILTY CHARACTERS
   AND FIXSCREEN REPLACES THEM)
```

A. Don't know. May be an editor bug or the way you are using it. If you add a line with #P followed immediately by a carriage return in the fig editor, a null is introduced into the line which stops compiling. (editor fix should be supplied)

THAT MYSTERIOUS fig-FORTH AMNESIA

Many fig-FORTH users have probably noticed the curious phenomenon I refer to as "amnesia" in their computers, and those who understand the method of the fig--FORTH dictionary search, no doubt understand it as well. It is an amusing, often perplexing, but usually useful property peculiar to fig-FORTH dictionaries.

Because names in fig-FORTH may have variable length, the distance between the start of the name and the link to the next name in the dictionary is also variable. Because the width (number of characters saved) is also allowed to be less than the actual number of characters in the name, one cannot rely on the count to provide the address of the link-field, given the address of the name-field. This is why the fig-FORTH compiler automatically sets the most significant bit of the first character and the last character in every name. By this device, one can scan a name forward or backward by looking for this bit.

In a dictionary search, the address in the link-field is followed to the beginning of the name-field of the previous word. If it is not a match to the key you are looking for, we scan forward in memory until the most significant bit tells us we have found the link-field to the next word. When a dictionary link is "broken" by clobbering RAM, an erroneous address is followed, and the system is said to "crash".

However, in fig-FORTH, the system does not always "die". In many cases, it is merely "wounded", displaying a strange kind of amnesia in which it has no recollection of recent definitions, but remembers with clarity its "childhood". What happens is this: the broken link sends the dictionary search off to a totally random part of memory (if you do not have 64K, it may address RAM where there are no boards!). Since it is not likely to find a match at this address, it scans forward for the most significant bit that marks the end of the "name". The odds are that it will eventually find one, mistake the next two bytes for a link, and follow another wild address somewhere else.

Now, depending on how much of your memory is filled with dictionary, and depending on what is in your unused RAM, the odds are not bad that after bouncing aimlessly around for awhile, the search may land in the middle of a valid name. One does not expect a match to compare with the middle of a name, but the search then scans for the most significant bit, finds a valid link, and gets back into the dictionary. What the "amnesia" has actually forgotten, then, is everything between the broken link and the point where the search re-enters the dictionary.

If your used RAM is large in comparison to FORTH, you are likely to find most of FORTH still available as a kind of crippled monitor to help you find out what went wrong without re-booting the system (which destroys the damage). Furthermore, since you now know the cause of this illness, you can exploit it to your advantage. Simply modify your boot-up RAM-check routine so that it leaves a pattern in your unused RAM, such that no matter how it is viewed, it will appear to be an address somewhere in the middle of a name-field, somewhere near the top of your basic FORTH and utilities. You will now find, to your delight, that when you "crash", you usually have your most powerful tools still at your disposal.

Users of FORTH, Inc. Micro-FORTH are not likely to observe this phenomenon. Because names are always exactly four characters long, the link field does not have to be scanned for; instead, it is found by simple arithmetic. In order to re-enter the dictionary, one must land by chance on the exact beginning of a name-field. Much more likely than this, is that the search will enter a loop in which it goes again to an address it has already visited, and get caught forever. Remember that the addresses found are by no means random. All you have to do is cover the most common ones.

Steve Munson
8071 E. 7th Street, #14
Buena Park, CA 90621

TRANSIENT DEFINITIONS

These utiliites 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 fig-FORTH definitions.

Philip Wasson

MORE WORDS ABOUT WORD

Robert D. Villwock
Microsystems, Inc.

In analyzing or proposing changes to any Standard definition, it is very important to concentrate on the details of the needed function and to avoid any preconceived notion of internal implementation details, unless, of course, the two are inseparable. If this is not done, we can severely and unnecessarily constrain future implementors from doing their best possible job, or, worse yet, find them avoiding the Standard entirely.

A good case in point is the word WORD. Since most FORTH implementors have favored using the "free space" above the dictionary to store tokens extracted by WORD, and further since their experience seems to be centered around small to medium sized application programs, it is tacitly assumed that this free space is arbitrarily large. In addition to storing tokens at HERE, PAD is usually also defined to float above the dictionary in this "unbounded" free space. Therefore, whether WORD handles tokens of length 128, 256 or even 1024 bytes is innocently discussed with the idea that the only issue involved is the length descriptor preceding the string!

However, whether this token buffer and PAD float above HERE or are fixed location buffers or some different scheme is devised, they consume real memory and are not really "free space". To illustrate, suppose we assume the traditional implementation for a moment and use HERE as the start of the token buffer used by WORD. The PAD is then usually floated at a location equal to HERE plus some constant. If WORD must handle tokens as long as 255 bytes, then PAD must be floated at least 256 bytes above HERE to prevent token extraction from corrupting the contents of PAD. The 79-STANDARD requires that PAD be able to hold at least 64 bytes, so now we're at HERE + 320 bytes.

If one is compiling a large application program, the dictionary will grow until eventually HERE + 320 hits the peg (whether it is a fixed boundary or the PSTACK bottom or whatever). When it does, no more compilation can take place (even though there is at least 320 bytes of unused dictionary left) without violating the Standard. If you permit further compilation, the size of PAD begins to drop below the minimum 64, which is not allowed. Even if you start automatically reducing the PAD offset so that it remains fixed in size, the token buffer begins shrinking and can no longer satisfy the 256 byte string requirement.

I'm trying to illustrate that "free space" is only "free" as long as all of memory isn't needed. When memory fills, these "free space" buffers prevent code from being compiled into their space. The floating buffer concept seems to obscure this fact more than if the token buffer and the PAD were given fixed, dedicated areas of memory.

If the token buffer must handle 1024 byte strings, the situation is even worse. We then have to stop compiling when the dictionary has over 1K bytes of space left! Since most of the time the tokens extracted by WORD are very short (31 characters or less), we pay a dear price to be able to handle the occasional long string, given that WORD must handle it, and WORD is defined as at present.

If you discard the notion that a more or less unbounded "free space" exists somewhere in memory, the approach to WORD's definition takes on a new facet. At Microsystems, we have developed several large applications using FORTH, which resulted in target compiled code in the range of 32K to 48K bytes, exclusive of the dictionary headers and the FORTH operating sysem software. When applications become that large, there isn't even room to hold all the names in memory at one time (even if constrained to 3 characters and length), let alone room to burn for large "free space" buffers! Our implementation, which is called proFORTH™, handles this problem by means of multiple dictionaries and ROM/RAM segment control with selective symbol purging. Names are classified as to their needed lifetimes during compilation. When the names are no longer needed, they are purged and their memory space is reclaimed. This allows much of the memory devoted to dictionary headers to be reused many times during compilation, thereby enabling very large applications to be compiled.

The foregoing is not a commercial for proFORTH, but rather is intended to illustrate that the scope of usage to which FORTH can be applied is very broad. In a situation where you have multiple dictionaries and are fighting for every byte of memory available, thinking in terms of storing unbounded tokens at HERE and floating PADs of arbitrary length becomes very incongruous. Admittedly, I've described a somewhat extreme situation, but it is not as rare as you may think. Microprocessor applications are getting more ambitious every day and sooner or later you will have a crowded memory condition. I think FORTH should be able to handle these situations gracefully, without having to deviate from the Standard.

When defining WORD, then, one objective should be to enable users to extract arbitrarily long tokens from the text stream but not force the implementor to provide an arbitrarily long memory buffer to accomplish it. While this may sound a little like trying to "have your cake and eat it too", a rather simple factoring of WORD can easily accomplish it. To illustrate my point, suppose we devise a more basic WORD called (WORD) and define it as follows:

```
: (WORD)    ( c -- a n )    BLK @ ?DUP
   IF BLOCK
   ELSE TIB @
   THEN >IN @ + SWAP ENCLOSE
   >IN +!  OVER - -ROT + SWAP ;
```

where ENCLOSE is defined as in the FIG glossary and -ROT is equivalent to ROT ROT.

This new (WORD) extracts the next token from the text stream, delimited by c, and leaves its address and length on the stack. Actually, the token is merely left in the input buffer (keyboard or disk) and a pointer to it is given. Thus, no additional or temporary buffer is needed. The user may now do anything he (she) wants with the string, including moving it to HERE if desired (and if it will fit).

For example, if you want to compile the token as a "dot-quote" string, a definition such as WORD, can be used.

```
: WORD,   (c -- )
  (WORD)  HERE OVER 1+  ALLOT SWAP OVER C!
    COUNT  CMOVE ;
```

If you want a blank-filled line put in PAD, the following could be used:

```
: TEXT    ( c -- ) PAD C/L 2+ BLANKS
   (WORD)  C/L MIN PAD C!  PAD
     COUNT CMOVE ;
```

For the routine compiler/interpreter job of extracting small (31 characters or less) tokens from the text stream, the following could be used:

```
: WORD  ( c -- a )
   (WORD)  WDSZ MIN  WBFR C!  WBFR COUNT 1+
     CMOVE  WBFR  ;
```

where WBFR is a "small" word buffer limited to WDSZ + 2. Note that except possibly for the self-imposed size limitation*, the last definition satisfies the 79-STANDARD definition of WORD.

If you will carefully examine these constructs, you can quickly discover that given (WORD) as the elementary form, the user can extract tokens of any size, put them wherever he wants, and format them with or without the trailing delimiter, or for that matter, the leading count byte (or 16 bit word if you prefer). In other words, the user ought to be able to do essentially anything that he may desire, but, the implementor need not provide any special, temporary buffers or arbitrary size just to

satisfy the Standard.

Using (WORD) as the fundamental token extractor allows implementors to compile dot quote strings, for example, without the need for any transitional buffers (see WORD,). On the other hand, if dot quote strings are acquired by the present form of WORD in the Standard, then the token buffer must be at least as large as the longest dot quote string, which is presently specified to be 127 characters.

One might argue that if the buffer is at HERE, there is no penalty since that is where the string must go anyway, and if it won't fit it can't be compiled. However, this line of reasoning is again limited by a parochial view that all FORTH implementations must be alike. If a system like proFORTH is being used, the target definition body can optionally be compiled "in place" separate from the dictionary header. There may be room for the string in the target segment of memory but not enough in the dictionary.

In conclusion, let me say that if there is sufficient memory, the user may declare all the buffers he wants, but we should not require that these buffers be preallocated by the implementor in order to satisfy the Standard. Therefore, I submit that my definition of (WORD) is a more fundamentally valuable function than WORD (as currently defined in the 79-STANDARD,) from which all others can be built without burning sometimes precious memory space. There are already enough buffers and such required (directly or indirectly) by the Standard. Let's not arbitrarily insist on more by accidently defining words in such a way as to force an implementor to provide them.

* I emphasize "possibly" because fortunately the Standard is not explicit as to the length of tokens that must be handled by WORD.

CORRECTION TO FEDIT

Sorry you had trouble with FEDIT. The listing was retyped at FIG and several typos creeped in. They are:

1. SCR 64 Line 10: compile should be COMPILE
2. SCR 65 Line 23: 1+/MOD should be 1+ 16 /MOD
3. SCR 67 Line 48: B/BUD should be B/BUF
4. SCR 67 Line 49: :e should be : .E
5. SCR 67 Line 50: + ALIN should be +ALIN

You are perfectly right that source text should be loadable. I talked to some of the people at FIG about this and they were acutely aware of the problem but they are simply not set up to directly reproduce listings into FD at the present time. They do the best job they can with the resources available to them, and they work darn hard at it. I can't fault them.

REPL is a pseudonym for the Fig-FORTH line editor definition, R . I used the pseudonym because FEDIT was the first program I wrote in FORTH and I really wasn't familiar enough with Vocabularies to comfortably use a word that was already used in the FORTH vocabulary.

Let me know how it works for you. If you would like a machine produced listing, I could run one for you from my current version.

Edgar H. Fey, Jr.
18 Calendar Court
La Grange, IL 60525

A HELPFUL UTILITY

Here's a short FORTH word of great utility that I use heavily in my screens. I hope you like it. Its name is CVD, which stands for "convert to decimal".

```
DECIMAL
: CVD
      BASE @ SWAP
      OVER /MOD
      ROT /MOD
      10 * +
      10 * +
;
```

I like to work in hexidecimal, but often make mistakes when using the words LOAD, LIST, and many of the FORTH screen editor words because I'm thinking in decimal when the system's in hex. If I do the following:

```
: LIST    CVD LIST ;
```

then 130 LIST lists screen 130 whether I'm in decimal or hex. It also works for any other base, as long as that base accepts the number.

As to how it works, a little work will show that CVD splits a three-digit number into its respective digits (IE, 130 becomes 1, 3, and 0) and reassembles the digits into the number that is, in decimal, the same as the keys pressed by the user.

Gregg Williams
BYTE Publications
PO Box 372
Hancock, NH 03449

CALL FOR PAPERS

1982 Rochester FORTH Conference
on
Data Bases and Process Control

May 17 through May 21, 1982

University of Rochester
Rochester, New York

The second annual Rochester FORTH Conference will be held in May, and will be hosted by the University of Rochester's Laboratory for Laser Energetics. This year's topics complement and extend the work described at the 1981 FORML Conference and the previous Rochester Conference. We believe that the areas of data bases and process control can be uniquely dealt with using FORTH.

There is a call for papers on the following topics:

1. Data Bases, including, but not limited to: hierarchical, network and relational models; scientific use; process control; and commercial systems.

2. Process Control, including, but not limited to: multitasking, meta-compilation, data acquisition and real time systems; video games.

3. Related concepts of: implementation, speed/space tradeoffs; user interactions; designer tools; and graphics.

Papers will be handled in either oral sessions or poster sessions, although oral papers will be refereed in accordance with conference direction, paper quality and topic. Please submit a 200 word abstract by March 15, 1982. The oral papers deadline is April 15, 1982, and the poster papers deadline is May 1, 1982. Send abstracts and papers to the conference chairman, Lawrence Forsley, by those dates. Please keep papers to a maximum of 10 printed pages. If this restriction causes a serious problem, contact us.

For more information, please contact the conference chairman at:

Lawrence P. Forsley
Laboratory for Laser Energetics
University of Rochester
250 East River Road
Rochester, New York 14623

A FORTH ASSEMBLER FOR THE 6502

by William F. Ragsdale

INTRODUCTION

This article should further polarize the attitudes of those outside the growing community of FORTH users. Some will be fascinated by a label-less, macro-assembler whose source code is only 96 lines long! Others will be repelled by reverse Polish syntax and the absence of labels.

The author immodestly claims that this is the best FORTH assembler ever distributed. It is the only such assembler that detects all errors in op-code generation and conditional structuring. It is released to the public domain as a defense mechanism. Three good 6502 assemblers were submitted to the FORTH Interest Group but each had some lack. Rather than merge and edit for publication, I chose to publish mine with all the submitted features plus several more.

Imagine having an assembler in 1300 bytes of object code with:

1. User macros (like IF, UNTIL,) definable at any time.

2. Literal values expressed in any numeric base, alterable at any time.

3. Expressions using any resident computation capability.

4. Nested control structures without labels, with error control.

5. Assembler source itself in a portable high level language.

OVERVIEW

Forth is provided with a machine language assembler to create execution procedures that would be time inefficient, if written as colon-definitions. It is intended that "code" be written similarly to high level, for clarity of expression. Functions may be written first in high-level, tested, and then re-coded into assembly, with a minimum of restructuring.

THE ASSEMBLY PROCESS

Code assembly just consists of interpreting with the ASSEMBLER vocabulary as CONTEXT. Thus, each word in the input stream will be matched according the Forth practice of searching CONTEXT first then CURRENT.

```
ASSEMBLER (now CONTEXT)
FORTH     (chained to ASSEMBLER)
user's    (CURRENT if one exits)
FORTH     (chained to user's vocab)
try for literal number
else, do error abort
```

The above sequence is the usual action of Forth's text interpreter, which remains in control during assembly.

During assembly of CODE definitions, Forth continues interpretation of each word encountered in the input stream (not in the compile mode). These assembler words specify operands, address modes, and op-codes. At the conclusion of the CODE definition a final error check verifies correct completion by "unsmudging" the definition's name, to make it available for dictionary searches.

RUN-TIME, ASSEMBLY-TIME

One must be careful to understand at what time a particular word definition executes. During assembly, each assembler word interpreted executes. Its function at that instant is called 'assembling' or 'assembly-time'. This function may involve op-code generation, address calculation, mode selection, etc.

The later execution of the generated code is called 'run-time'. This distinction is particulary important with the conditionals. At assembly time each such word (i.e., IF, UNTIL, BEGIN, etc.) itself 'runs' to produce machine code which will later execute at what is labeled 'run-time' when its named code definition is used.

AN EXAMPLE

As a practical example, here's a simple call to the system monitor, via the NMI address vector (using the BRK opcode).

```
CODE MON ( exit to monitor )
    BRK, NEXT JMP, END-CODE
```

The word CODE is first encountered, and executed by Forth. CODE builds the following name "MON" into a dictionary header and calls ASSEMBLER as the CONTEXT vocabularly.

The "(" is next found in FORTH and executed to skip til ")". This method skips over comments. Note that the name after CODE and the ")" after "(" must be on the same text line.

OP-CODES

BRK, is next found in the assembler as the op-code. When BRK, executes, it assembles the byte value 00 into the dictionary as the op-code for "break to monitor via "NMI".

Many assembler words names end in ",". The significance of this is:

1. The comma shows the conclusion of a logical grouping that would be one line of classical assembly source code.

2. "," compiles into the dictionary; thus a comma implies the point at which code is generated.

3. The "," distinguishes op-codes from possible hex numbers ADC and ADD.

NEXT

Forth executes your word definitions under control of the address interpreter, named NEXT. This short code routine moves execution from one definition, to the next. At the end of your code definition, you must return control to NEXT or else to code which returns to NEXT.

RETURN OF CONTROL

Most 6502 systems can resume execution after a break, since the monitor saves the CPU register contents. Therefore, we must return control to Forth after a return from the monitor. NEXT is a constant that specifies the machine address of Forth's address interpreter (say $0242). Here it is the operand for JMP,. As JMP, executes, it assembles a machine code jump to the address of NEXT from the assembly time stack value.

SECURITY

Numerous tests are made within the assembler for user errors:

1. All parameters used in CODE definitions must be removed.

2. Conditionals must be properly nested and paired.

3. Address modes and operands must be allowable for the op-codes

These tests are accomplished by checking the stack position (in CSP) at the creation of the definition name and comparing it with the position at END-CODE. Legality of address modes and operands is insured by means of a bit mask associated with each operand.

Remember that if an error occurs during assembly, END-CODE never executes. The result is that the "smudged" condition of the definition name remains in the "smudged" condition and will not be found during dictionary searches.

The user should be aware that one error not trapped is referencing a definition in the wrong vocabulary:

i.e., 0= of ASSEMBLER when you want 0= of FORTH

(Editor's note: the listing assumes that the figFORTH error messages are already available in the system, as follows:

?CSP issues the error message "DEFINITION NOT FINISHED" if the stack position differs from the value saved in the user variable CSP, which is set at the creation of teh definition name.

?PAIRS issues the error message "CONDITIONALS NOT IMPAIRED" if its two arguments do not match.

3 ERROR prints the error message "HAS INCORRECT ADDRESS MODE".)

SUMMARY

The object code of our example is:

```
305  983 4D 4F CE     CODE MON
305D 4D 30            link field
305F 61 30            code field
3061 00               BRK
3062 4C 42 02         JMP NEXT
```

OP-CODES, revisited

The bulk of the assembler consists of dictionary entries for each op-code. The 6502 one mode op-codes are:

```
BRK,  CLC,  CLD,  CLI,  CLV,
DEX,  DEY,  INX,  INY,  NOP,
PHA,  PHP,  PLA,  PLP,  RTI,
RTS,  SEC,  SED,  SEI,  TAX,
TAY,  TSX,  TXS,  TXA,  TYA,
```

When any of these are executed, the corresponding op-code byte is assembled into the dictionary.

The multi-mode op-codes are:

```
ADC,  AND,  CMP,  EOR,  LDA,
ORA,  SBC,  STA,  ASL,  DEC,
INC,  LSR,  ROL,  ROR,  STX,
CPX,  CPY,  LDX,  LDY,  STY,
JSR,  JMP,  BIT,
```

These usually take an operand, which must already be on the stack. An address mode may also be specified. If none is given, the op-code uses z-page or absolute addressing. The address modes are determined by:

Symbol	Mode	Operand
.A	accumulator	none
#	immediate	8 bits only
,X	indexed X	z-page or absolute
,Y	indexed Y	z-page or absolute
X)	indexed indirect X	z-page only
)Y	indirect indexed Y	z-page only
)	indirect	absolute only
none	memory	z-page or absolute

EXAMPLES

Here are examples of Forth vs. conventional assembler. Note that the operand comes first, followed by any mode modifier, and then the op-code mnemonic. This makes best use of the stack at assembly time. Also, each assembler word is set off by blanks, as is required for all Forth source text.

```
    .A ROL,   ROL A
   1 # LDY,   LDY #1
 DATA ,X STA, STA DATA,X
 DATA ,Y CMP, CMP DATA,Y
   6 X) ADC,  ADC (06,X)
 POINT )Y STA, STA (POINT),Y
VECTOR ) JMP,  JMP (VECTOR)
```

(.A distinguishes from hex number 0A)

The words DATA and VECTOR specify machine addresses. In the case of "6)X ADC," the operand memory address $0006 was given directly. This is occasionally done if the usage of a value doesn't justify devoting the dictionary space to a symbolic value.

6502 CONVENTIONS

Stack Addressing

The data stack is located in z-page, usually addressed by "Z-PAGE,X". The stack starts near $009E and grows downward. The X index register is the data stack pointer. Thus, incrementing X by two removes a data stack value; decrementing X twice makes room for one new data stack value.

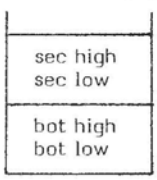
Sixteen bit values are placed on the stack according to the 6502 convention; the low byte is at low memory, with the high byte following. This allows "indexed, indirect X" directly off a stack value.

The bottom and second stack values are referenced often enough that the support words BOT and SEC are included. Using

BOT LDA, assembles LDA (0,X) and
SEC ADC, assembles ADC (2,X)

BOT leaves 0 on the stack and sets the address mode to ,X. SEC leaves 2 on the stack also setting the address mode to ,X.

Here is a pictorial representation of the stack in z-page.



<==X offset above $0000

Here is an examples of code to "or" to the accumulator four bytes on the stack:

```
BOT   LDA,   LDA (0,X)
BOT 1+ ORA,  ORA (1,X)
SEC   ORA,   ORA (2,X)
SEC 1+ ORA,  ORA (3,X)
```

To obtain the 14-th byte on the stack: BOT 13 + LDA,

RETURN STACK

The Forth Return Stack is located in the 6502 machine stack in Page 1. It starts at $01FE and builds downward. No lower bound is set or checked as Page 1 has sufficient capacity for all (non--recursive) applications.

By 6502 convention the CPU's register points to the next free byte below the bottom of the Return Stack. The byte order follows the convention of low significance byte at the lower address.

Return stack values may be obtained by: PLA, PLA, which will pull the low byte, then the high byte from the return stack. To operate on aribitrary bytes, the method is:

1) save X in XSAVE

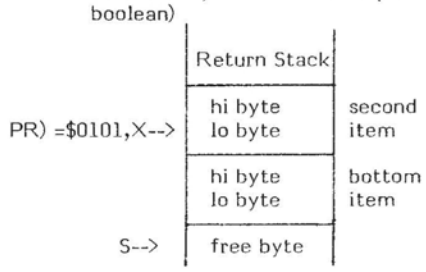
2) execute TSX, to bring the S register to X.

3) use RP) to address the lowest byte of the return stack. Offset the value to address higher bytes. (Address mode is automatically set to ,X.)

4) Restore X from XSAVE.

As an example, this definition nondestructively tests that the second item on the return stack (also the machine stack) is zero.

```
CODE IS-IT  ( zero ? )
    XSAVE STX, TSX,  (setup for
    return stack)
    RP) 2+ LDA, RP) 3 + ORA,
    ( or 2nd item's two bytes
    together)
0= IF, INY, THEN, ( if zero, bump
Y to one)
    TYA, PHA, XSAVE LDX, (save
    low byte, rstore data stack)
    PUSH JMP, END-CODE ( push
    boolean)
```



FORTH REGISTERS

Several Forth registers are available only at the assembly level and have been given names that return their memory addresses. These are:

IP address of the Interpretive Pointer, specifying the next Forth address which will be interpreted by NEXT.

W address of the pointer to the code field of the dictionary definition just interpreted by NEXT. W-1 contains $6C, the op-code for indirect jump. Therefore, jumping to W-1 will indirectly jump via W to the machine code for the definition.

UP User Pointer containing address of the base of the user area.

N a utility area in z-page from N-1 thru N+7.

CPU Registers

When Forth execution leaves NEXT to execute a CODE definition, the following conventions apply:

1. The Y index register is zero. It may be freely used.

2. The X index register defines the low byte of the bottom data stack item relative to machine address $0000.

3. The CPU stack pointer S points one byte below the low byte of the bottom return stack item. Executing PLA, will pull this byte to the accumulator.

4. The accumulator may be freely used.

5. The processor is in the binary mode and must be returned in that mode.

XSAVE

XSAVE is a byte buffer in z-page, for temporary storage of the X register. Typical usage, with a call which will change X, is:

```
CODE DEMO
    XSAVE STX, USER'S JSR,
    ( which will change X )
    XSAVE LDX, NEXT JMP,
    END-CODE
```

N Area

When absolute memory registers are required, use the 'N Area' in the base page. These registers may be used as pointers for indexed/indirect addressing or for temporary values. As an example of use, see CMOVE in the system source code.

The assembler word N returns the base address (usually $00D1). The N Area spans 9 bytes, from N-1 thru N+7. Conventionally, N-1 holds one byte and N, N+2, N+4, N+6 are pairs which may hold 16-bit values. See SETUP for help on moving values to the N Area.

It is very important to note that many Forth procedures use N. Thus, N may only be used within a single code definition. Never expect that a value will remain there, outside a single definition!

```
CODE DEMO  HEX
   6 # LDA, N 1 - STA,
     (setup a counter)

BEGIN, 8001 BIT,
     (tickle a port)

       N 1 - DEC,
         (decrement the counter)

   0= UNTIL,  NEXT JMP, END-CODE
     (loop till negative)
```

SETUP

Often we wish to move stack values to the N area. The sub-routine SETUP has been provided for this purpose. Upon entering SETUP the accumulator specifies the quantity of 16-bit stack values to be moved to the N area. That is, A may be 1, 2, 3, or 4 only:

```
       3 # LDA,  SETUP JSR,

  stack before   N after    stack after
       H high                    H
       G low              bot--> G_
       F_            F
       E_            E_
       D             D
sec--> C_            C_
       B             B
bot--> A_       N--> A_
```

CONTROL FLOW

Forth discards the usual convention of assembler labels. Instead, two replacements are used. First, each Forth definition name is permanently included in the dictionary. This allows procedures to be located and executed by name at any time as well as be compiled within other definitions.

Secondly, within a code definition, execution flow is controlled by label-less branching according to "structured programming". This method is identical to the form used in colon-definitions. Branch calculations are done at assembly time by temporary stack values placed by the control words:

BEGIN, UNTIL, IF, ELSE, THEN,

Here again, the assembler words end with a comma, to indicate that code is being produced and to clearly differentiate from the high-level form.

One major difference occurs! High-level flow is controlled by run-time boolean values on the data stack. Assembly flow is instead controlled by processor status bits. The programmer must indicate which status bit to test, just before a conditional branching word (IF, and UNTIL,).

Examples are:

```
PORT LDA, 0= IF, <a> THEN,
    (read port, if equal to zero do <a> )

PORT LDA, 0= NOT IF, <a> THEN,
    (read port, if not equal to zero
    do <a> )
```

The conditional specifiers for 6502 are:

CS	test carry set processor status	C=1 in
0<	byte less than zero	N=1
0=	equal to zero	Z=1
CS NOT	test carry clear	C=0
0 <NOT	test positive	N=0
0= NOT	test not equal zero	Z=0

The overflow status bit is so rarely used, that it is not included. If it is desired, compile:

```
ASSEMBLER DEFINITIONS  HEX
50 CONSTANT VS      (test overflow
set)
```

CONDITIONAL LOOPING

A conditional loop is formed at assembler level by placing the portion to be repeated between BEGIN, and UNTIL,:

```
   6 # LDA,  N STA,
  (define loop counter in N)
BEGIN,  PORT DEC,
  (repeated action)
    N DEC,      0= UNTIL,
  (N reaches zero)
```

First, the byte at address N is loaded with the value 6. The beginning of the loop is marked (at assembly time) by BEGIN,. Memory at PORT is decremented, then the loop counter in N is decremented. Of course, the CPU updates its status register as N is decremented. Finally, a test for Z=1 is made; if N hasn't reached zero, execution returns to BEGIN,. When N reaches zero (after executing PORT DEC, 6 times) execution continues ahead after UNTIL,. Note that

BEGIN, generates no machine code, but is only an assembly time locator.

CONDITIONAL EXECUTION

Paths of execution may be chosen at assembly in a similar fashion and done in colon-definitions. In this case, the branch is chosen based on a processor status condition code.

```
PORT LDA,   0= IF,   (for zero set)
THEN, (continuing code)
```

In this example, the accumulator is loaded from PORT. The zero status is tested if set (Z=1). If so, the code (for zero set) is executed. Whether the zero status is set or not, execution will resume at THEN,.

The conditional branching also allows a specific action for the false case. Here we see the addition of the ELSE, part.

```
PORT LDA, 0= IF,  < for zero set>
          ELSE, <for zero clear>
          THEN, <continuing code>
```

The test of PORT will select one of two execution paths, before resuming execution after THEN,. The next example increments N based on bit D7 of a port:

```
PORT LDA,          ( fetch one byte )
  0< IF, N DEC,    ( if D7=1, decrement
                     N )
     ELSE, N INC,  ( if D7=0, increment
                     N )
     THEN,         ( continue ahead )
```

CONDITIONAL NESTING

Conditionals may be nested, according to the conventions of structured programming. That is, each conditional sequence begun (IF, BEGIN,) must be terminated (THEN, UNTIL,) before the next earlier conditional is terminated. An ELSE, must pair with the immediately preceding IF,.

```
BEGIN, < code always executed>
   CS IF, <code if carry set>
        ELSE,  <code if carry clear>
        THEN,
   0= NOT UNTIL,  ( loop till condition
                    flag is non-zero)
        <code that continues onward>
```

Next is an error that the assembler security will reveal.

```
BEGIN, PORT LDA,
   0= IF, BOT INC,
        0= UNTIL,  ENDIF,
```

The UNTIL, will not complete the pending BEGIN, since the immediately preceding IF, is not completed. An error trap will occur at UNTIL, saying "conditionals not paired".

RETURN OF CONTROL, revisited

When concluding a code definition, several common stack manipulations often are needed. These functions are already in the nucleus, so we may share their use just by knowing their return points. Each of these returns control to NEXT.

POP POPTWO	remove one 16-bit stack values.
POPTWO	remove two 16-bit stack values.
PUSH	add two bytes to the data stack.
PUT	write two bytes to the data stack, over the present bottom of the stack.

Our next example complements a byte in memory. The bytes' address is on the stack when INVERT is executed.

```
CODE INVERT  ( a memory byte )  HEX
  BOT X) LDA,     (fetch byte addressed
                   by stack)
    FF # EOR,     (complement accumu-
                   lator)
  BOT X) STA,  ( replace in memory )
  POP JMP,  END-CODE  ( discard
                   pointer from stack,
                   return to NEXT )
```

A new stack value may result from a code definition. We could program placing it on the stack by:

```
CODE ONE  ( put 1 on the stack )
     DEX, DEX,  ( make room on the
                  data stack)
     1 # LDA, BOT STA,  (store low byte)
     BOT 1+ STY,  ( hi byte stored from Y
                  since = zero)
     NEXT JMP,  END-CODE
```

A simpler version could use PUSH:

```
CODE ONE
   1 # LDA,  PHA,  ( push low byte to
   machine stack )
   TYA,  PUSH  JMP,  ( high byte to
   accumulator, push to data stack )
   END-CODE
```

The convention for PUSH and PUT is:

1. push the low byte onto the machine stack.
2. leave the high byte in the accumulator.
3. jump to PUSH or PUT.

PUSH will place the two bytes as the new bottom of the data stack. PUT will over-write the present bottom of the stack with the two bytes. Failure to push exactly one byte on the machine stack will disrupt execution upon usage!

FOOLING SECURITY

Occasionally we wish to generate unstructured code. To accomplish this, we can control the assembly time security checks, to our purpose. First, we must note the parameters utilized by the control structures at assembly time. The notation below is taken from the assembler glossary. The --- indicates assembly time execution, and separate input stack values from the output stack values of the words execution.

```
BEGIN, ==>                    --- addrB 1
UNTIL, ==>  addrB 1  cc  ---

IF,    ==>           cc   --- addrI 2
ELSE,  ==>  addrI 2       --- addrE 2
THEN,  ==>  addrI 2       ---
       or   addrE 2       ---
```

The address values indicate the machine location of the corresponding 'B'EGIN, 'I'F, or 'E'LSE,. cc represents the condition code to select the processor status bit referenced. The digit 1 or 2 is tested for conditional pairing.

The general method of security control is to drop off the check digit and manipulate the addresses at assembly time. The security against errors is less, but the programmer is usually paying intense attention to detail during this effort.

To generate the equivalent of the high level:

```
BEGIN <a> WHILE <b> REPEAT
```

we write in assembly:

```
BEGIN, DROP ( the check digit
                1, leaving addrB)
          <a>
  CS IF,  ( leaves addrI and digit
          2)
             <b>
    ROT ( bring addrB to bottom)
    JMP, (to addrB of BEGIN, )
  ENDIF,  ( complete false for-
          ward branch from IF, )
```

It is essential to write the assembly time stack on paper, and run through the assembly steps, to be sure that the check digits are dropped and re-inserted at the correct points and addresses are correctly available.

ASSEMBLER GLOSSARY

#	Specify 'immediate' addressing mode for the next op-code generated.
)Y	Specify 'indirect indexed Y' addressing mode for the next op-code generated.

,X Specify 'indexed X' addressing mode for the next op-code generated.

,Y Specify 'indexed Y' addressing mode for the next op-code generated.

.A Specify accumulator addressing mode for the next op-code generated.

0< --- cc (assembling)
Specify that the immediately following conditional will branch based on the processor status bit being negative (Z=1), i.e., less than zero. The flag cc is left at assembly time; there is no run--time effect on the stack.

0= --- cc (assembling)
Specify that the immediately following conditional will branch based on the processor status bit being equal to zero (Z=1). The flag cc is left at assembly time; there is no run-time effect on the stack.

;CODE Used to conclude a colon-definition in the form:
: <name> . . . ;CODE
<assembly code> END-CODE
Stop compilation and terminate a new defining word <name> . Set the CONTEXT vocabulary to ASSEMBLER, assembling to machine code the following nmenonics. An existing defining word must exist in name prior to ;CODE.

When <name> later executes in the form:
<name> <namex>
the definition <namex> will be created with its execution procedure given by the machine code following <name> . That is, when <namex> is executed, the address interpreter jumps to the code following ;CODE in <name> .

ASSEMBLER in FORTH
Make ASSEMBLER the CONTEXT vocabulary. It will be searched first when the input stream in interpreted.

BEGIN, --- addr 1 (assembling)
--- (run-time)
Occurs in a CODE definition in the form:
BEGIN, . . . cc UNTIL,
At run-time, BEGIN, marks the start of an assembly sequence repeatedly executed. It serves as the return point for the corresponding UNTIL,. When reaching UNTIL, a branch to BEGIN, will occur if the processor status bit given by cc is false; otherwise execution continues ahead.

At assembly time, BEGIN, leaves the dictionary pointer address addr and the value 1 for later testing of conditionary pairing by UNTIL,.

BOT --- n (assembling)
Used during code assembly in the form:

BOT LDA, or BOT 1+ X) STA,

Addresses the bottom of the data stack (containing the low byte) by selecting the ,X mode and leaving n=0, at assembly time. This value of n may be modified to another byte offset into the data stack. Must be followed by a multi-mode op-code mnemonic.

CODE A defining word used in the form:

CODE <name> . . . . END-CODE

to create a dictionary entry for <name> in the CURRENT vocabulary. Name's code field contains the address of its parameter field. When <name> is later executed, the machine code in this parameter field will execute. The CONTEXT vocabulary is made ASEMBLER, to make available the op-code mnemonics.

CPU n --- (compiling assembler)
An assembler defining word used to crate assembler mnemonics that have only one addressing mode:

EA CPU NOP,

CPU creates the work NOP, with its op-code EA as a parameter. When NOP, later executes, it assembles EA as a one byte op-code.

CS --- cc (assembling)
Specify that the immediately following conditional will branch based on the processor carry is set (C=1). The flag cc is left at assembly time; there is no run-time effect on the stack.

ELSE, --- (run-time)
addr1 2 --- addr2 2
(assembling)
Occurs within a code definition in the form:
cc IF, <true part> ELSE,
<false part> THEN,
At run-time, if the condition code specified by cc is false, execution will skip to the machine code following ELSE,. At assembly time ELSE, assembles a forward jump to just after THEN, and resolves a pending forward branch from IF. The values 2 are used for error checking of conditional pairing.

END-CODE
An error check word marking the end of a CODE definition. Successful execution to and including END-CODE will unsmudge the most recent CURRENT vocabulary definition, making it available for execution. END-CODE also exits the ASSEMBLER making CONTEXT the same as CURRENT. This word previously was named C;

IF, cc --- addr 2 (assembly time)
--- addr 2 (assembly-time)
Occurs within a code definition in the form:
cc IF, <true part> ELSE,
false part THEN,
At run time, IF, branches based on the condition code cc, (0< or 0= or CS). If the specified processor status is true, execution continues ahead, otherwise branching occurs to just after ELSE, (or THEN, when ELSE, is not present). At ELSE, execution resumes at the corresponding THEN,.

When assembling, IF, creates an unresolved forward branch based on the condition code cc, and leaves addr and 2 for resolution of the branch by the corresponding ELSE, or THEN,. Conditionals may be nested.

INDEX --- addr (assembling)
An array used within the assembler, which holds bit patterns of allowable addressing modes.

IP --- addr (assembling)
Used in a code definition in the form:

IP STA, or IP)Y LDA,

A constant which leaves at assembly time the address of the pointer to the next FORTH execution address in a colon-definition to be interpreted.

At run-time, NEXT moves IP ahead within a colon-definition. Therefore, IP points just after the execution address being interpreted. If an in-line data structure has been compiled (i.e., a character string), indexing ahead by IP can access this data:

IP STA, or IP)Y LDA,

loads the third byte ahead in the colon-definition being interpreted.

M/CPU n1 n2 --- (compiling assembler)
An assembler defining word used to create assembler mnemonics that have multiple address modes:

1C6E 60 M/CU ADC,

M/CPU creates the word ADC, with two parameters. When ADC, later executes, it uses these parameters, along with stack values and the contents of MODE to calculate and assemble the correct op-code and operand.

MEM Used within the assembler to set MODE to the default value for direct memory addressing, z-page.

MODE --- addr
A variable used within the assembler, which holds a flag indicating the addressing mode of the op-code being generated.

N --- addr (assembling)
Used in a code definition in the form:

N 1 - STA, or N 2+)Y ADC,

A constant which leaves the address of a 9 byte workspace in z-page. Within a single code definition, free use may be made over the range N-1 thru N+7. See SETUP.

NEXT --- addr (assembling)
A constant which leaves the machine address of the Forth address interpreter. All code definitions must return execution to NEXT, or code that returns to NEXT (i.e., PUSH, PUT, POP, POPTWO).

NOT ccl --- ccl (assembly-time)
When assembling, reverse the condition code for the following conditional. For example:

0= NOT IF, <true part> THEN,

will branch based on 'not equal to zero'.

POP --- addr (assembling)
n --- (run-time)

A constant which leaves (during assembly) the machine address of the return point which, at run-time, will pop a 16-bit value from the data stack and continue interpretation.

POPTWO --- addr (assembling)
n1 n2 --- (run-time)
A constant which leaves (during assembly) the machine address of the return point which, at run--time, will pop two 16-bit values from the data stack and continue interpretation.

PUSH --- addr (assembling)
--- n (run-time)
A constant which leaves (during assembly) the machine address of the return point which, at run--time, will add the accumulator (as high-byte) and the bottom machine stack byte (as low-byte) to the data stack.

PUT --- addr (assembling)
n1 --- n2 (run-time)
A constant which leaves (during assembly) the machine address of the return point which, at run--time, will write the accumulator (as high-byte) and the bottom machine stack byte (as low-byte) over the existing data stack 16-bit value (n1).

RP) --- (assembly-time)
Used in a code definition in the form:

RP) LDA, or RP) 3+ STA,

Address the bottom byte of the return stack (containing the low byte) by selecting the ,X mode and leaving n=$101. n may be modified to another byte offset. Before operating on the return stack the X register must be saved in XSAVE and TSX, be executed; before returning to NEXT, the X register must be restored.

SEC --- n (assembling)
Identical to BOT, except that n=2. Addresses the low byte of the second 16-bit data stack value (third byte on the data stack).

THEN, --- (run-time)
addr 2 --- (assembly-time)
Occurs in a code definition in the form:

cc IF, <true part> ELSE,
<false part> THEN,

At run-time THEN, marks the conclusion of a conditional structure. Execution of either the true part or false part resumes following THEN,. When assembling addr and 2 are used to resolve the pending forward branch to THEN,.

UNTIL, --- (run-time)
addr 1 cc --- (assembling)
Occurs in a CODE definition in the form:

BEGIN, . . . cc UNTIL,

At run-time, UNTIL, controls the conditional branching back to BEGIN,. If the processor status bit specified by cc is false, execution returns to BEGIN,; otherwise execution continues ahead.

At assembly time, UNTIL, assembles a conditional relative branch to addr based on the condition code cc. The number 1 is used for error checking.

UP --- addr (assembling)
Used in a code definition in the form:

UP LDA, or UP)Y STA,

A constant leaving at assembly time the address of the pointer to the base of the user area. i.e.,

HEX 12 # LDY, UP)Y LDA,

load the low byte of the sixth user variable, DP.

W --- addr (assembling)
Used in a code definition in the form:

W 1+ STA, or W 1 - JMP, or
W)Y ADC,

A constant which leaves at assembly time the address of the pointer to the code field (execution address) of the Forth dictionary word being executed. Indexing relative to W can yield any byte in the definition's parameter field. i.e.,

2 # LDY, W)Y LDA,

fetches the first byte of the parameter field.

X) Specify 'indexed indirect X' addressing mode for the next op-code generated.

XSAVE --- addr (assembling)
Used in a code definition in the form:

XSAVE STX, or XSAVE LDX,

A constant which leaves the address at assembly time of a temporary buffer for saving the X register. Since the X register indexes to the data stack in z-page, it must be saved and restored when used for other purposes.

FORTH Assembler for 6502 by W. F. Ragsdale July 1, 1980

```
SCR # 81
  0 (  FORTH-65 ASSEMBLER                                  WFR-79JUN03 )
  1 HEX
  2 VOCABULARY  ASSEMBLER  IMMEDIATE     ASSEMBLER  DEFINITIONS
  3
  4 ( REGISTER ASSIGNMENT SPECIFIC TO IMPLEMENTATION  )
  5 E0  CONSTANT  XSAVE        DC  CONSTANT  W       DE  CONSTANT  UP
  6 D9  CONSTANT  IP           D1  CONSTANT  N
  7
  8 (  NUCLEUS LOCATIONS ARE IMPLEMENTATION SPECIFIC )
  9 '  (DO)  0E  +    CONSTANT  POP
 10 '  (DO)  0C  +    CONSTANT  POPTWO
 11 '  LIT  13  +  CONSTANT  PUT
 12 '  LIT  11  +  CONSTANT  PUSH
 13 '  LIT  18  +  CONSTANT  NEXT
 14 '  EXECUTE  NFA  11  -  CONSTANT  SETUP
 15

SCR # 82
  0 (     ASSEMBLER, CONT.                                 WFR-78OCT03 )
  1 0   VARIABLE  INDEX       -2  ALLOT
  2 0909 , 1505 , 0115 , 8011 , 8009 , 1D0D , 8019 , 8080 ,
  3 0080 , 1404 , 8014 , 8080 , 8080 , 1C0C , 801C , 2C80 ,
  4
  5 2  VARIABLE  MODE
  6 : .A   0 MODE ! ;     : #    1 MODE ! ;     : MEM  2 MODE ! ;
  7 : ,X   3 MODE ! ;     : ,Y   4 MODE ! ;     : X)   5 MODE ! ;
  8 : )Y   6 MODE ! ;     : )    F MODE ! ;
  9
 10 : BOT        ,X    0  ;      ( ADDRESS THE BOTTOM OF THE STACK *)
 11 : SEC        ,X    2  ;         ( ADDRESS SECOND ITEM ON STACK *)
 12 : RP)        ,X  101  ;       ( ADDRESS BOTTOM OF RETURN STACK *)
 13
 14
 15

SCR # 83
  0 (  UPMODE,  CPU                                        WFR-78OCT23 )
  1
  2 : UPMODE   IF  MODE @ 8 AND 0=  IF  8 MODE +!  THEN THEN
  3      1 MODE @  0F AND  -DUP  IF  0  DO  DUP + LOOP  THEN
  4      OVER 1+ @ AND  0=  ;
  5
  6 : CPU   <BUILDS  C,  DOES>  C@   C,  MEM  ;
  7      00 CPU BRK,   18 CPU CLC,   D8 CPU CLD,   58 CPU CLI,
  8      B8 CPU CLV,   CA CPU DEX,   88 CPU DEY,   E8 CPU INX,
  9      C8 CPU INY,   EA CPU NOP,   48 CPU PHA,   08 CPU PHP,
 10      68 CPU PLA,   28 CPU PLP,   40 CPU RTI,   60 CPU RTS,
 11      38 CPU SEC,   F8 CPU SED,   78 CPU SEI,   AA CPU TAX,
 12      A8 CPU TAY,   BA CPU TSX,   8A CPU TXA,   9A CPU TXS,
 13      98 CPU TYA,
 14
 15
```

```
SCR # 84
  0 (  M/CPU,    MULTI-MODE OP-CODES                    WFR-79MAR26 )
  1 : M/CPU    <BUILDS  C,   ,  DOES>
  2         DUP 1+ @ 80 AND    IF  10 MODE +! THEN    OVER
  3         FF00 AND UPMODE UPMODE     IF MEM CR LATEST ID.
  4         3  ERROR  THEN  C@  MODE  C@
  5         INDEX + C@ + C,     MODE C@ 7 AND    IF MODE C@
  6         0F AND 7 <    IF C, ELSE , THEN    THEN  MEM  ;
  7
  8     1C6E 60 M/CPU ADC,   1C6E 20 M/CPU AND,   1C6E C0 M/CPU CMP,
  9     1C6E 40 M/CPU EOR,   1C6E A0 M/CPU LDA,   1C6E 00 M/CPU ORA,
 10     1C6E E0 M/CPU SBC,   1C6C 80 M/CPU STA,   0D0D 01 M/CPU ASL,
 11     0C0C C1 M/CPU DEC,   0C0C E1 M/CPU INC,   0D0D 41 M/CPU LSR,
 12     0D0D 21 M/CPU ROL,   0D0D 61 M/CPU ROR,   0414 81 M/CPU STX,
 13     0486 E0 M/CPU CPX,   0486 C0 M/CPU CPY,   1496 A2 M/CPU LDX,
 14     0C8E A0 M/CPU LDY,   048C 80 M/CPU STY,   0480 14 M/CPU JSR,
 15     8480 40 M/CPU JMP,   0484 20 M/CPU BIT,

SCR # 85
  0 (  ASSEMBLER CONDITIONALS                           WFR-79MAR26 )
  1 : BEGIN,    HERE  1  ;                    IMMEDIATE
  2 : UNTIL,    ?EXEC >R 1 ?PAIRS R> C, HERE 1+ - C, ; IMMEDIATE
  3 : IF,       C,  HERE  0  C,  2  ;         IMMEDIATE
  4 : THEN,     ?EXEC  2  ?PAIRS  HERE  OVER  C@
  5           IF SWAP ! ELSE  OVER 1+ - SWAP C!  THEN  ; IMMEDIATE
  6 : ELSE,     2 ?PAIRS HERE 1+   1 JMP,
  7             SWAP HERE OVER 1+ - SWAP  C!  2  ;  IMMEDIATE
  8 : NOT    20  +  ;                        ( REVERSE ASSEMBLY TEST )
  9 90  CONSTANT  CS                  ( ASSEMBLE TEST FOR CARRY SET )
 10 D0  CONSTANT  0=               ( ASSEMBLER TEST FOR EQUAL ZERO )
 11 10  CONSTANT  0<            ( ASSEMBLE TEST FOR LESS THAN ZERO )
 12 90  CONSTANT  >=    ( ASSEMBLE TEST FOR GREATER OR EQUAL ZERO )
 13                    ( >= IS ONLY CORRECT AFTER SUB, OR CMP,  )
 14
 15

SCR # 86
  0 (  USE OF ASSEMBLER                                 WFR-79APR28 )
  1 : END-CODE                              ( END OF CODE DEFINITION *)
  2       CURRENT @ CONTEXT !    ?EXEC ?CSP SMUDGE ;  IMMEDIATE
  3
  4 FORTH  DEFINITIONS    DECIMAL
  5 : CODE                   ( CREATE WORD AT ASSEMBLY CODE LEVEL *)
  6       ?EXEC  CREATE  [COMPILE]  ASSEMBLER
  7       ASSEMBLER  MEM  !CSP  ;       IMMEDIATE
  8
  9 ( LOCK ASSEMBLER INTO SYSTEM )
 10 '  ASSEMBLER  CFA     '  ;CODE  8  +  !  ( OVER-WRITE SMUDGE )
 11 LATEST  12  +ORIGIN  !  ( TOP NFA )
 12 HERE    28  +ORIGIN  !  ( FENCE )
 13 HERE    30  +ORIGIN  !  ( DP )
 14 '  ASSEMBLER  6  +    32  +ORIGIN  !  ( VOC-LINK )
 15 HERE  FENCE  !
```

APPLICATIONS

A TECHNICAL TUTORIAL: TABLE LOOKUP EXAMPLES

Henry Laxen
Laxen and Harris, Inc.

One of the problems with FORTH, as with every rich language, is that given an idea, there are many ways of expressing it. Some are more eloquent than others, but it takes practice and experience to create the poetry and avoid the mundane.

This article is written to illustrate 4 different ways of implementing a simple Table Lookup operation. The goal is the following: we want to create a FORTH word, named DAYS/MONTH which behaves as follows: Given an index on the stack which is the month number, such as 1 for January and 12 for December, we want to return the number of days in that month, in a normal year. Thus if we execute 6 DAYS/MONTH it should return 30, which is the number of days in the month June. I will use the Starting FORTH dialect in this paper, not fig-FORTH, so if you try to type in the examples, they probably won't work unless you are running a system that behaves as described in Starting FORTH (or the 79-Standard).

Our first attempt at solving this problem uses the FORTH word VARIABLE. The code is as follows:

```
VARIABLE 'DAYS/MONTH  22 ALLOT

 31 'DAYS/MONTH          !
 28 'DAYS/MONTH   2  +   !
 31 'DAYS/MONTH   4  +   !
 30 'DAYS/MONTH   6  +   !
 31 'DAYS/MONTH   8  +   !
 30 'DAYS/MONTH  10  +   !
 31 'DAYS/MONTH  12  +   !
 31 'DAYS/MONTH  14  +   !
 30 'DAYS/MONTH  16  +   !
 31 'DAYS/MONTH  18  +   !
 30 'DAYS/MONTH  20  +   !
 31 'DAYS/MONTH  22  +   !
 : DAYS/MONTH ( INDEX --- VALUE )
     1- 2* 'DAYS/MONTH * @ ;
```

There is nothing significant about the ' (apostrophe), I only prefaced the VARIABLE name with it because I want to use the word DAYS/MONTH later. Now, what happened is that VARIABLE allocated 2 bytes in the dictionary for the value of DAYS/MONTH. The 22 ALLOT then allocated another 22 bytes, for a total of 24 bytes, or 2*12 cells. We next proceeded to initialize the values that were allocated by explicitly calculating the offsets and storing in the appropriate location. Finally, we defined DAYS/MONTH as a colon definition which performs arithmetic on the index, adds it to the start of the table, and fetches the result.

Now, let's look at another way of doing this that requires less typing and is also more general. We will first define a word called TABLE which will aid us in the creation of tables like the one above. What we will do is first place the initial values of the TABLE on the stack, together with the number of the initial values. Then, we will define TABLE to copy these into the dictionary. Here is how it works:

```
: TABLE    ( Nn Nn-1 ... N1 n --- )
   0 DO , LOOP ;

CREATE 'DAYS/MONTH
   31 30 31 30 31 31 30 31 30 31 28
       31 12 TABLE

: DAYS/MONTH    ( INDEX --- VALUE )
    1- 2* 'DAYS/MONTH + @ ;
```

Now this is considerably less typing than the first way of doing it, but notice that I had to reverse the order of the days per month since that is the way stacks behave. I used CREATE instead of VARIABLE because it does not allocate any space for the initial value, but otherwise behaves just like VARIABLE. The access word DAYS/MONTH is identical to before.

I am still not satisfied, however, so let's try it yet another way. Instead of defining TABLE to add values to the dictionary with , (comma) why not just use , directly?

```
CREATE 'DAYS/MONTH
   31 , 28 , 31 , 30 , 31 , 30 ,
        31 , 31 , 30 , 31 , 30 , 31 ,


: DAYS/MONTH  ( INDEX --- VALUE )
   1- 2* 'DAYS/MONTH + @ ;
```

Now we are getting somewhere!! If we simply use the FORTH word , (comma) to add the value to the dictionary, see how simple and readable it becomes. The values are just typed in and separated by commas!! Is it possible to improve even on this? Funny you should ask. There is a quality that can be abstracted from the definition of DAYS/MONTH, namely that of table lookup. Wouldn't it be nice if we didn't need to create that extra name 'DAYS/MONTH simply so we could access it later in our : definition. Well, that is where our friend CREATE DOES> comes in.

Instead of defining a particular instance of a TABLE, we will create a new Defining Word called TABLE, which acts as follows. It creates a new entry in the dictionary which when executed, uses the value that was placed on the stack as an index into itself and returns the contents of that location. It would be coded as follows:

```
:  TABLE
   CREATE     ( --- )
   DOES>      ( INDEX --- VALUE )
      SWAP  1- 2* + @ ;

TABLE DAYS/MONTH
   31 , 28 , 31 , 30 , 31 , 30 ,
        31 , 31 , 30 , 31 , 30 , 31 ,
```

Now we have truly generalized the problem and solve it in an elegant way. We have defined a new data type, called TABLE, which is capable of defining new words. Part of the definition of TABLE was specifying the run-time behavior of the word being defined. This is the code following the DOES>. We then use the , (comma) technique discovered above to initialize the table. Note that DAYS/MONTH is now just a special case of TABLE, and is in fact defined by the new defining word TABLE.

The above examples illustrate the immense diversity available in FORTH. There is no obvious right or wrong, and the simplest and usually most general solution to a given problem must be discovered, usually by trial and error. FORTH's biggest virtue, in my opinion, is that it makes the trial and error process extremely efficient, and therefore, allows people to experiment and discover the best solution for themselves.

HELP WANTED

Programmers needeed to produce new polyFORTH systems and applications. Two to three years extensive FORTH experience working with mini/micro computers and peripherals.

Contact: Patricia Jones

FORTH, INC.
2309 Pacific Coast Highway
Hermosa Beach, CA 90254
(213) 372-8493

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fig-FORTH NOVA GROUP

Mr. Francis Saint, 2218 Lulu, Wichita, KS 67211, (316) 261-6280 (days) has formed a FIG Group to trade information and assistance between fig-FORTH NOVA users.

Pub. Comment: Hope to see a new, clean listing. How about some other specific groups!

THE GAME OF REVERSE

M. Burton

REVERSE is a number game written in FORTH, primarily as an exercise in array manipulation. The object of REVERSE is to arrange a list of numbers (1 through 9) in ascending numerical order from left to right. Moves are made by reversing a subset of the list (from the left). For example, if the current list is

2 3 4 5 1 6 7 8 9

and four numbers are reversed, the list will be

5 4 3 2 1 6 7 8 9

then if five numbers are reversed, the game is won.

1 2 3 4 5 6 7 8 9

To leave a game that is in progress, simply reverse zero numbers.

REVERSE Glossary

SEED --
The number seed for the pseudorandom number generator. SEED is initialized as the REVERSE words are compiled, by hitting any key on the console.

MOVES --
Keeps track of the number of moves made in a REVERSE game. If more than fifteen moves are made to win, you haven't got the hang of the game.

RND range -- random.number
The pseudorandom number generator, courtesy of FORTH DIMENSIONS. RND generates random.number in the range 0 through range-1. RND is used to scramble the number list.

DIM n --
A defining word used in the form
n DIM xxxx
Produces an n+1 length word array named xxxx, with elements 0 through n. For the REVERSE application, element 0 is not used.

Y/N -- flag
Solicits an input string from the console, then checks the first character of the string for an uppercase or lower-

```
SCR # 228
  0 ( The Game of Reverse  [SEED, MOVES, RND, DIM, Y/N] 101281-MPB )
  1
  2 0  VARIABLE  SEED        ( Seed for random number generator )
  3 0  VARIABLE  MOVES       ( Number of reverses so far )
  4    CR  ." Please depress any key:"  ( Fertilize the seed )
  5       KEY  SEED  !
  6
  7 : RND             ( Random number generator    range -- rnd# )
  8     SEED @  259  *  3  +  32767  AND  DUP  SEED ! 32767  */  ;
  9
 10 : DIM                 ( Reserve an integer word array  n -- )
 11     <BUILDS  1+  2  *  ALLOT
 12       DOES>  ;
 13
 14 : Y/N               ( Get a Y or N response      -- flag )
 15     PAD  80  EXPECT  PAD  C@  CR  CR  95  AND  89  =  ;   -->

SCR # 229
  0 ( The Game of Reverse  [Game instructions]          101281-MPB )
  1
  2 : INSTRUCT  CR  CR   18  SPACES  ." The Game of REVERSE"
  3             CR  CR  ." Would you like instructions? "  Y/N
  4  IF   ." The object of the game is to arrange a random list"
  5    CR ." of nine numbers  into ascending numerical order in"
  6    CR ." as few moves as possible  by reversing a subset of"
  7    CR ." the  list.  For example, given  the  random  list," CR
  8    CR ."          5  2  4  8  7  3  9  1  6  "  CR
  9    CR ." reversing  a  subset  of 4 would  yield  the list," CR
 10    CR ."          8  4  2  5  7  3  9  1  6  "  CR
 11    CR ." To quit the game, simply reverse 0."  CR  CR
 12  THEN  ;
 13
 14 -->
 15

SCR # 230
  0 ( The Game of Reverse  [ARRAY operations]           101281-MPB )
  1
  2 9  DIM  ARRAY    ( Reserve a ten word array )
  3
  4 : A@             ( Fetch an array word   index -- array.value )
  5     2  *  ARRAY  +  @  ;
  6
  7 : A!             ( Store an array word   array.value\index -- )
  8     2  *  ARRAY  +  !  ;
  9
 10 : AINIT          ( Initialize ARRAY          -- )
 11     10  1  DO  I  DUP  A!  LOOP  ;
 12
 13 : A.             ( Print ARRAY               -- )
 14     CR  ." The list is now..."
 15     CR  6  SPACES  10  1  DO  I  A@  3  .R  LOOP  ;  -->

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```

```
SCR # 231
  0 ( The Game of Reverse  [ARRAY operations, cont.]     100781-MPB )
  1
  2 : ASCRAMBLE                ( Mix up the array values     -- )
  3     1  9  DO  I  RND  1+   ( Calculate K )
  4               I     A@     ( Get ARRAY[I] value )
  5               OVER  A@     ( Get ARRAY[K] value )
  6               I     A!     ( Store ARRAY[K] in ARRAY[I] )
  7               SWAP  A! -1  ( Store ARRAY[I] in ARRAY[K] )
  8           +LOOP  ;
  9
 10 : GETIN                    ( Get amount to reverse     -- n )
 11     BEGIN  CR  ." Reverse how many? "
 12            PAD  80  EXPECT  PAD  @  48  -
 13            DUP  0<  OVER  9  >  OR  DUP
 14            IF  CR  ." Only 0 through 9 is allowed. "  THEN  0=
 15     UNTIL  CR  ;     -->

SCR # 232
  0 ( The Game of Reverse  [ARRAY operations, cont.]     100781-MPB )
  1
  2 : AREVERSE                 ( Reverse a subset of ARRAY   n -- )
  3     DUP  2  /  1+  1       ( Loop limits are 1 to [n/2]+1 )
  4     DO DUP  I  -  1+       ( Calculate index n-I+1 )
  5        DUP   A@  SWAP      ( Get ARRAY[n-I+1] )
  6        I     A@            ( Get ARRAY[I] )
  7        SWAP  A!            ( Store ARRAY[I] in ARRAY[n-I+1] )
  8        I     A!            ( Store ARRAY[n-I+1] in ARRAY[I] )
  9     LOOP  DROP  ;
 10
 11 : ACHECK                   ( Check for ascending seq.    -- flag )
 12     1  10  1  DO
 13                  I  DUP  A@  =  AND
 14               LOOP  ;
 15 -->

SCR # 233
  0 ( The Game of Reverse  [REVERSE definition]          101281-MPB )
  1
  2 : REVERSE                      ( Play the game )
  3     INSTRUCT  AINIT
  4     BEGIN
  5        ASCRAMBLE  0  MOVES  !
  6           BEGIN
  7              A.  GETIN  DUP  0=
  8                IF  1  ELSE
  9                   AREVERSE  1  MOVES  +!  ACHECK
 10                THEN
 11           UNTIL
 12        A.  CR  ." You made "  MOVES  @  .  ." reversals."  CR
 13        CR  ." Care to play again? "  Y/N  0=
 14     UNTIL
 15     CR  ." Thanks for playing REVERSE... "  CR  CR  ;   ;S

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ok
```

case 'Y'. If a 'Y' is present, the flag returned is true. For any other character, the flag is false.

INSTRUCT --
Prints the name of the game and then asks if instructions are required. If yes, instructions are displayed.

ARRAY --
A ten word array that contains the number list that REVERSE works on. Element zero of the list is not used.

A@ index -- array.value
Fetches the index array.value of ARRAY and leaves it on the data stack.

A! array.value index --
Stores array.value into the index element of ARRAY.

AINIT --
Initializes ARRAY with the numbers 1 through nine in game winning order.

A. --
Displays ARRAY in an understandable format.

ASCRAMBLE --
Using RND, scrambles the numbers in ARRAY for a new REVERSE game.

GETIN -- n
Solicits the number of elements of the list to reverse. If any character other than 0 through 9 is entered, GETIN prints "Only 0 through 9 is allowed.", and solicits another number.

AREVERSE n --
Reverses the nth length subset of ARRAY, starting from element 1.

ACHECK -- flag
Checks ARRAY for proper ascending numerical order. If ARRAY is in the proper order, ACHECK returns a true flag.

REVERSE --
The game definition. Uses all previously defined words to play the game of REVERSE.

THE 31 GAME

Written by Tony Lewis 11/81

The "31 Game" is an attempt to use FORTH fundamentals to produce an entertaining result. The object is to entice you into anlyzing both the game itslef and the methods used to produce it. The game buffs might wish to know that I have been an avid "player" (not gambler!) for over 30 years and have made extensive practical studies of various games. Any phone communication is welcome. I am two years behind in my written correspondence; so sending me letters which require replies will prove futile. The program is my first effort in FORTH. However, I have had extensive experience with six different main frame assemblers plus a little COBOL of the late 60's vintage. Any constructive suggestions on general style and technique are welcome, but I am not really interested in being told that I could have shaved 100 microseconds from my run time or saved fifteen bytes of memory. In fact, there are indeed extraneous "Cr's" which were included to get good hard copy, also.

This program was written in micromotion (c) FORTH-79 Version 1.2 to be run on a 48K *Apple II.

Therefore, the following words are non-standard but included in the micromotion FORTH.

Home - position the cursor to the upper left corner of the CRT and clear the CRT to blanks.

CV and CH are used to position the input cursor anywhwere on the text window per Ex. 4 CV 10 CH moves the cursor to the 4th (pun) row 10th column of screen.

SETINV, SETFLASH, and SETNORM set flags in the Apple output subroutines which respectively cause all subsequent characters to be displayed on the text screen inverse, flashing and normal mode without affecting charcters already displayed.

In closing, I wish to thank Bill Ragsdale for his gracious support and I especially acknowledge the incredibly patient treatment I received from Phil Wasson of Micromotion as he neatly led me through my FORTH initiation.

Tony Lewis
100 Mariner Green Dr.
Corte Madera, CA 94925
(415) 924-1481
(415) 924-4216 (late hours)

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```
SCR#51
: HOWTO31 HOME ( 31 GAME-TONY LEWIS) ."
      31 GAME                BY TONY LEWIS
'31' IS PLAYED WITH A DECK OF 24 CARDS
CONTAININING ONLY THE ACES THRU SIXES.
EACH OF TWO PLAYERS ALTERNATELY DRAWS
CARDS FROM THE DECK, ONE CARD AT A TIME.
A RUNNING TOTAL IS KEPT OF THE COMBINED"
                                        ."
SUM OF THE CARDS DRAWN. THE PLAYER WHO
ARRIVES AT THE SUM OF 31 EXACTLY WINS.
IF NEITHER PLAYER CAN MAKE 31 EXACTLY,
THEN THE PLAYER WHO MUST GO OVER 31
LOSES! THE GAME MAY APPEAR TOO EASY, BUT
IT IS DECEPTIVE. WHEN [OR IF?] YOU HAVE"
                                        ."
WON THREE GAMES, TRY TO BEAT THE PROGRAM
FOR 'THE BIG BET' BY TYPING IN 'B'
RATHER THAN 'Y' OR 'N' WHEN 'NEW GAME?'
COMES UP. THE 'BIG BET' IS A TWO GAME
SERIES. YOU GO FIRST IN GAME 1 AND
SECOND IN GAME 2. YOU MAY BE SURPRISED!"
CR CR CR  ." HIT ANY KEY TO BEGIN"
KEY  DROP HOME 6 CV ;              -->

SCR#52
( WORDS OF WISDOM       31 BY TONY LEWIS)
( THE 'ANSWER' PAGE IS NEXT. IT DOESN'T
REQUIRE ANY SKILL TO FIGURE OUT WHAT THE
 CONSTANTS REALLY ARE! THEY ARE ENCODED
SO THAT YOU CAN ENTER AND COMPILE THE
GAME WITHOUT DISCOVERING ITS PRINCIPLE.
REMEMBER, THE PURPOSE OF THIS PROJECT
WAS TO GET YOU TO FIRST EXAMINE THE GAME
BY PLAYING IT, THEN FIGURE OUT HOW TO
APPROACH THE PROBLEM OF PROGRAMMING IT,
AND FINALLY GO BACK AND COMPARE YOUR
METHODS TO MINE. THE GAME IS AMUSING
AND IS A LITTLE KNOWN CINCH BAR BET. IF
YOU TAKE THE TIME TO ENTER IT ONTO YOUR
FORTH DISC, YOU SHOULD HAVE FUN BOTH
ANALYZING IT AND THEN ENTERTAINING [OR
HUSTLING] FRIENDS AND FAMILY WITH IT.
OF COURSE WHEN PLAYING AT A BAR YOU MUST
USE A REAL DECK OF CARDS AS IT WOULD
PROBABLY TEND TO DISCOURAGE WAGERING IF
YOU SHOULD BRING YOUR 'MICRO' WITH YOU.)
 -->

SCR#53
( ENCODED CONSTANTS     31 BY TONY LEWIS)
 ( NOTE: THESE CONSTANTS ARE USED ONLY
 TO CONCEAL THE SOLUTION OF THE GAME.
 NOT TO MAKE THE CODING HARD TO FOLLOW!)

 0 CONSTANT K1
 0 CONSTANT K2
 0 CONSTANT K3
 0 CONSTANT K4

 HEX
 : CODECONS
   CD EF *  AB BC * -  41C8 -  ' K1 !
   DC FE *  BA CB * -  46C7 -  ' K2 !
   CE ED *  AC BD * -  3FB6 -  ' K3 !
   EC DE *  CA DB * -  1FD8 -  ' K4 ! ;

 DECIMAL
 -->

SCR#54
( SETUP AND UTILITY WORDS 31-TONY LEWIS)
CREATE DECK
0 , 4 , 4 , 4 , 4 , 4 , 4 , 0 ,
VARIABLE CARDSUM   VARIABLE GAMESWON

: NEWGAME     ( FIRST, NEW DECK )
  7 1 DO I 2* DECK + 4 SWAP ! LOOP
  0 CARDSUM !  HOME  4 CV ;

: SHOWDECKSUM CR CR
  ." THE DECK NOW CONTAINS "
  7 1 DO I ( NOT J'! ) 2*
         DECK + C@ ( DUCK O DO )  DUP
           IF 1+ 1 CR DO J .  LOOP
           ELSE DROP
           THEN
      LOOP  12 CH
 ." THE RUNNING TOTAL IS " CARDSUM @ . ;

: BADPLAY
  ( FLAG BAD PLAY)  0    CR CR
  ." BAD TYPE-IN"  SHOWDECKSUM ;
 -->

SCR#55
( UTILITY WORDS CONT.  31 BY TONY LEWIS)

: UPDATEDECKSUM ( 1 TO 6 NOW ON STACK)
  DUP 2* DUP DECK + C@ DUP ( ANY LEFT?)
   IF 1- ( UPDATE DECK) SWAP DECK + C!
     CARDSUM C@ + CARDSUM C! ( NEW SUM)
       2 ( CARD-IN-DECK FLAG)
   ELSE DROP DROP DROP 0
   THEN ;
 -->

SCR#56
( MAINLINE WORDS        31 BY TONY LEWIS)
: PLAYERMOVE  CR CR
  ." TYPE IN CARD 1 - 6 " KEY CR
  48 - ( FROM ASCII) DUP DUP DUP
 ( CHECK VALID ENTRY)
  7 <
   IF 0>    ( CARD 1 - 6 ?)
    IF UPDATEDECKSUM SWAP
     HOME ." YOUR CARD WAS A " . DUP
     0=    ( IS CARD IN THE DECK?)
     IF DROP ( FLAG BAD PLAY)  0
      CR CR ." CARD NOT IN DECK"
      SHOWDECKSUM
     THEN
    ELSE DROP DROP BADPLAY
    THEN
   ELSE DROP DROP DROP BADPLAY
   THEN ;
 -->

SCR#57
( MAINLINE WORDS CONT. 31 BY TONY LEWIS)
: MYCARD       CR CR
  IF  ( CHECK 1ST PLAY SWITCH)
   K3 RANDOM 1+ DUP   UPDATEDECKSUM DROP
  ELSE K1 DUP  CARDSUM C@ +
   K2 -  K1 MOD  -  DUP
   UPDATEDECKSUM
    0= ( T FLAG ON VALID CHOICE)
    IF DROP 1 DUP UPDATEDECKSUM
      IF
      ELSE DROP 2 UPDATEDECKSUM
      THEN    ( FLAG=CARD, SO NO DROP)
    THEN
  THEN ." MY PLAY IS " . SHOWDECKSUM

 -->

SCR#58
( MAINLINE WORDS CONT. 31 BY TONY LEWIS)

: YOURCARD
  BEGIN PLAYERMOVE
  ( ILLEGAL PLAY LEAVES 0 ON STACK)
      UNTIL SHOWDECKSUM
    0 ( PLAYER MADE LAST PLAY) ;

: YOUWIN CR CR SETINV
  ." OH RATS! YOU WIN." SETNORM
  GAMESWON C@ 1+  GAMESWON C! ;



: YOULOSE CR CR SETINV
  ." YOU LOSE. BETTER LUCK NEXT TIME."
  SETNORM ;
 -->

SCR#59
( MAINLINE WORDS CONT. 31 BY TONY LEWIS)
: NORMAL31  HOME 7 CV
." DO YOU WANT FIRST PLAY? TYPE Y OR N."
  CR  KEY 78 = ( N)
  IF 1 ( 1ST MOVE) MYCARD  ELSE YOURCARD
  THEN 0 SWAP ( SET UP LOOP)
 BEGIN
   IF ( TRUE FLAG SET ON MYCARD)
    31 CARDSUM C@ <
     IF YOUWIN  1+ ( SET LOOP EXIT)
     ELSE 31 CARDSUM C@ =
      IF YOULOSE 1+  ELSE YOURCARD 0
      THEN
     THEN
   ELSE ( RETURN FROM YOURCARD)
        31 CARDSUM C@ <
     IF YOULOSE 1+
     ELSE 31 CARDSUM C@ =
      IF YOUWIN 1+   ELSE 0 MYCARD 0
      THEN         ( NOT 1ST MOVE)
     THEN
   THEN
 UNTIL  0 ( LOOP BACK IN MAIN31) ;    -->
```

```
SCR#60
( MAINLINE WORDS CONT. 31 BY TONY LEWIS
: MYBIGBET1 CR CR
  K1 DUP CARDSUM C@ +  K2 -  K1 MOD  -
   DUP UPDATEDECKSUM 0=

  IF DROP K3 DUP  UPDATEDECKSUM  DROP
  THEN ." MY PLAY IS " . SHOWDECKSUM 3 ;

: MYBIGBET2 CR CR
  IF DUP UPDATEDECKSUM DROP
  ELSE K1 CARDSUM C@ K2 - K1 MOD - DUP
   UPDATEDECKSUM 0=
    IF DROP K4 DUP UPDATEDECKSUM DROP
    THEN
  THEN ." MY PLAY IS " . SHOWDECKSUM 3 ;
 -->

SCR#61
( MAINLINE WORDS CONT. 31 BY TONY LEWIS)
: BIGBET1
  YOURCARD
 BEGIN
  IF ( TRUE FROM MYBIGBET1)
   31 CARDSUM C@ <
    IF YOUWIN  1  ( SET LOOP EXIT)
    ELSE 31 CARDSUM C@ =
     IF YOULOSE 1
     ELSE YOURCARD  0
     THEN
    THEN
  ELSE ( RETURN FROM YOURCARD)
   31 CARDSUM C@ <
    IF YOULOSE 1
    ELSE 31 CARDSUM C@ =
     IF YOUWIN  1
     ELSE MYBIGBET1 0
     THEN
    THEN
  THEN
 UNTIL ;
 -->

SCR#62
( MAINLINE WORDS CONT. 31 BY TONY LEWIS)
: BIGBET2
   3 MYBIGBET2
  BEGIN
   IF 31 CARDSUM C@ =
    IF YOULOSE 1
    ELSE YOURCARD 0
    THEN
   ELSE 31 CARDSUM C@ <
    IF YOULOSE 1
    ELSE 0 ( NOT 1ST) MYBIGBET2 0
    THEN
   THEN
  UNTIL ;
 -->

SCR#63
( MAINLINE WORDS CONT. 31 BY TONY LEWIS)

: BIGBET  5 HOME                          ."
WELCOME TO 'BIG BET', THE FINAL PHASE OF
 THE 31 GAME. TWO GAMES WILL BE PLAYED."
CR ." YOU WILL GO FIRST IN GAME ONE AND
I WILL GO FIRST IN GAME TWO. GOOD LUCK."

 BIGBET1
 CR CR
." HIT ANY KEY AND I WILL BEGIN GAME 2."
  CR KEY DROP NEWGAME
SETFLASH ." BIG BET GAME 2 THE FINALE"
CR CR SETNORM

 BIGBET2
CR                                        ."
WELL DID YOU HAVE THE CORRECT ANALYSIS?
 IF SO, THEN SEE IF YOU CAN FIGURE OUT"
CR                                        ."
WHO WINS WITH A 1ST CARD OF ONE OR TWO.
IT'S A TOUGH COMBINATORIAL PROBLEM!!"
1 ( SET FINAL EXIT IN MAIN31) :   -->
```

```
SCR#64
( PLAY THE GAME OF 31  BY TONY LEWIS)
: MAIN31 ( LOGIC SHELL) 0 GAMESWON !
  BEGIN  CR CR
   ." NEW GAME? "
   ." TYPE Y OR N OR B(BIG BET)."
  CR CR KEY DUP 78 - ( CHECK FOR N)
 ( FALSE LEAVES 78 ON STACK FOR 'UNTIL')
   IF NEWGAME   66 = ( B)
    IF GAMESWON C@ 2 >
     IF BIGBET
     ELSE HOME 0 ." YOU HAVE WON "
      GAMESWON C@ DUP . ." GAME" 1 =
        IF ." "
        ELSE ." S."
        THEN CR
          ." YOU MUST WIN 3 GAMES TO "
          ." PLAY 'BIG BET'."
     THEN
    ELSE NORMAL31
    THEN
   THEN
  UNTIL ;
: 31GAME  HOWTO31 CODECONS MAIN31 ;

OK
CODECONSA MAIN31

NEW GAME? TYPE Y OR N OR B(BIG BET).

DO YOU WANT FIRST PLAY? TYPE Y OR N.


MY PLAY IS 2

THE DECK NOW CONTAINS
1 1 1 1
2 2 2
3 3 3 3
4 4 4 4
5 5 5 5
6 6 6 6      THE RUNNING TOTAL IS 2

TYPE IN CARD 1 - 6
YOUR CARD WAS A 3

THE DECK NOW CONTAINS
1 1 1 1
2 2 2
3 3 3
4 4 4 4
5 5 5 5
6 6 6 6      THE RUNNING TOTAL IS 5

MY PLAY IS 5

THE DECK NOW CONTAINS
1 1 1 1
2 2 2
3 3 3
4 4 4 4
5 5 5
6 6 6 6      THE RUNNING TOTAL IS 10

TYPE IN CARD 1 - 6
YOUR CARD WAS A 6

THE DECK NOW CONTAINS
1 1 1 1
2 2 2
3 3 3
4 4 4 4
5 5 5
6 6 6        THE RUNNING TOTAL IS 16

MY PLAY IS 1

THE DECK NOW CONTAINS
1 1 1
2 2 2
3 3 3
4 4 4 4
5 5 5
6 6 6        THE RUNNING TOTAL IS 17

TYPE IN CARD 1 - 6
YOUR CARD WAS A 3

THE DECK NOW CONTAINS
1 1 1
2 2 2
3 3
4 4 4 4
5 5 5
6 6 6        THE RUNNING TOTAL IS 20

MY PLAY IS 4

THE DECK NOW CONTAINS
1 1 1
2 2 2
3 3
4 4 4
5 5 5
6 6 6        THE RUNNING TOTAL IS 24

TYPE IN CARD 1 - 6
YOUR CARD WAS A 5

THE DECK NOW CONTAINS
1 1 1
2 2 2
3 3
4 4 4
5 5
6 6 6        THE RUNNING TOTAL IS 29

MY PLAY IS 2

THE DECK NOW CONTAINS
1 1 1
2 2
3 3
4 4 4
5 5
6 6 6        THE RUNNING TOTAL IS 31

YOU LOSE. BETTER LUCK NEXT TIME.

NEW GAME? TYPE Y OR N OR B(BIG BET).

YOU HAVE WON 0 GAMES.
YOU MUST WIN 3 GAMES TO PLAY 'BIG BET'.

NEW GAME? TYPE Y OR N OR B(BIG BET).

OK
```

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SIMULATED TEKTRONICS 4010 GRAPHICS WITH FORTH

by Timothy Huang
Portland, OR 97211

In this article, I am going to tell a true story. For those people wh think FORTH is a religion, they might just consider this to be my testimony.

Last November, I had access to a very little known, but well built microcomputer -- MX 964/2 by Columbia Data Products, Inc. of Maryland. This little machine has two Z-80A CPUs. One is for the Host and the other for terminal. There are 64 K of RAM in the Host, and 32 K of the Terminal RAM is dedicated to the 512 x 256 bit mapped graphics. It also includes a 9" CRT, 2 double density drives, keyboard, 4 serial ports, and 4 parallel ports. Its all in one piece. It boots up with whatever operating system is on the disk after powered up and the carriage return key has been pressed. Beautiful isn't it?

However, there is a big problem, as with most microcomputer companies, the instruction manuals are terrible. And I mean terrible! Let me just give you one examle: "For this information, please see figure ___", only to find there was no such figure and no page number.

Graphics are one of the most important features with this machine. 512 x 256 bit mapped graphic is the best that can be expected under the price allowance. There are quite a few well known microcomputers on the market claiming High Resolution Graphics. But those High Resolution ones are just like a big blob compared with the individual pixel that bit mapped. So, I have a nice machine with all the fancy graphic capabilities, but lacking the key to open it. Anxiety mounts up quickly.

I have a friend who's an excellent 8080/Z80 assembly programmer. He implemented UCSD Pascal for a microcomputer. Naturally, since he was the first one, it seemed logical to seek his help. With a poorly written computer manual

```
Screen # 10
  0 ( Video controls for Columbia MX?64      TDH     12/09/81 )
  1 FORTH DEFINITIONS DECIMAL
  2 : GOTOXY ( x  y  --- )
  3          0 MAX 25 MIN 32 + SWAP
  4          0 MAX 79 MIN 32 +
  5          31 EMIT EMIT EMIT ;
  6
  7 : HOME 25 EMIT ;          : CLR-VIDEO     26 EMIT ;
  8 : CLR CLR-VIDEO HOME ;    : CLEARSCREEN   CLR     ;
  9
 10 : DW-C  10 EMIT ;         : UP-C  11 EMIT ;         : LT-C 8 EMIT
 11 : RT-C  12 EMIT ;         : BELL   7 EMIT ;
 12
 13   CLREOS   28 EMIT ;      : CLREOL    29 EMIT ;
 14 : CLRLINE  21 EMIT ;
 15
Screen # 11
  0 ( Graphic Package  -  1                  TDH     12/09/80 )
  1
  2 0 VARIABLE X   0 VARIABLE Y   0 VARIABLE L   0 VARIABLE TM
  3 0 VARIABLE XI  0 VARIABLE YI
  4
  5   ESC 27 EMIT ;  FF 12 EMIT ;  GS  29 EMIT ( vector ) ;
  6   US  31 EMIT ( alpha ) ;      CAN 24 EMIT ( non-grafic ) ;
  7 : EM  25 EMIT ( clear video memory ) ;
  8 : WHITE ESC 97  EMIT ;         : BLACK ESC 127 EMIT ;
  9
 10
 11
 12
 13
 14
 15
Screen # 12
  0 ( Graphic Package - 2                    TDH     12/09/80 )
  1
  2 : VECTOR ( n --- Lo, Hi )
  3          1023  AND      32  /MOD  ;
  4
  5 : XGEN   ( LoX , HiX --- )
  6          32 +   EMIT    64 +   EMIT ;
  7 : YGEN   ( LoY , HiY --- )
  8          32 +   EMIT    96 +   EMIT ;
  9
 10 : PRE-OUT ( n,m --- )
 11          VECTOR YGEN VECTOR XGEN ;
 12
 13 : PAGE  ( enter alpha from vector )
 14          ESC    FF  ;
 15
Screen # 13
  0 ( Graphic Package        - 3             TDH     12/09/80 )
  1
  2   INIT
  3          PAGE GS 32 EMIT  96 EMIT  32 EMIT  64 EMIT ;
  4
  5   ENDRAW
  6          QUIT ;
  7
  8   DRAW  ( x y --- )
  9          DUP Y !          SWAP DUP X !    SWAP PRE-OUT    ;
 10
 11 : GMOVE ( x y --- )
 12          GS      DRAW    ;
 13
 14
 15
```

```
Screen # 14
  0 ( Graphic Package          - 4                TDR      12/09/80 )
  1
  2 : RDRAW ( Relative DRAW )
  3         Y @ +    SWAP     X @ + SWAP        DRAW
  4
  5 : RMOVE ( Relative MOVE )
  6         GS       RDRAW    ;
  7
  8 : ACURSOR        ( alphacursor   x y --- )
  9         GS       DRAW     US       ;
 10
 11 : SCROLL         CAN CR ." press FUNC & 8 keys " ;
 12
 13 : LINE-ERASE
 14         BLACK    X @      Y @      PRE-OUT ;
 15

Screen # 15
  0 ( Graphic Package          - 5                TDR      12/09/80 )
  1
  2 : INIT0
  3         INIT  ROT L ! DUP Y ! SWAP DUP X ! SWAP GMOVE ;
  4 : SQUARE          ( i x y --- )
  5         INIT0    X @ L @ + DUP X ! Y @ DRAW       ( ---/ )
  6                  X @ Y @ L @ + DUP Y ! DRAW       ( UP   )
  7                  X @ L @ - DUP X ! Y @ DRAW       ( ---- )
  8                  X @ Y @ L @ - DUP Y ! DRAW       ( DOWN ) ;
  9
 10   ERASESQU       ( i x y --- )
 11         INIT0    X @ L @ + X ! LINE-ERASE         ( ---) )
 12                  Y @ L @ + Y ! LINE-ERASE         ( UP   )
 13                  X @ L @ - X ! LINE-ERASE         ( ---- )
 14                  Y @ L @ - Y ! LINE-ERASE         ( DOWN ) ;
 15

Screen # 16
  0 ( Graphic Package          - 6                TDR      12/09/80 )
  1
  2   INIT1 ( advance x & y, check range )
  3         L @ X @ XI @ + DUP DUP DUP 0 < IF DROP DROP DROP 0 DUP
  4         ELSE 1023 > IF DROP DROP 1023 DUP THEN THEN X
  5         Y @  YI @ + DUP DUP DUP 0 < IF DROP DROP DROP 0 DUP
  6         ELSE 779 > IF DROP DROP 779 DUP THEN THEN Y    ;
  7
  8 : INIT2 L @ X @ < @ .                INIT0 YI . XI ! YM
  9
 10   MANYSQUARES ( i x y im xi yi --- )
 11         INIT0 SQUARE YM @ 1 - 0  DO INIT1 SQUARE LOOP ;
 12
 13   DELAYED        1000 0 DO LOOP ; ( 10 milliseconds )
 14   2DELAY         2 0 DO DELAYED LOOP ; ( 140 millsec  )
 15
```

(we at least knew that the graphic part simulates Tektronics 4010), he spent a whole week just trying to draw one mere square along the edges of the CRT. Seemingly it would be an easy job, but even so it never came near to what he would have liked. Later on, I spent a couple of weeks twiddling with Microsoft BASIC compiler and it also produced lousy results.

At the same time, I received my 8080 fig-FORTH listing. So, I typed the whole 60 K of assembly listing with the lousiest text editor (i.e., ED. COM). It was a monumental job. Nevertheless, I had the fig-FORTH up and running.

By now, I was very desperate to get it going. Equipped with the FORTH power and the poor manual, I set forth to try the graphics again. Again, I sought help from a friend who works for Tektronics and is experienced with FORTH. With FORTH, the whole task turned into a very simple job, compared to the previous attempts we had with the assembly and BASIC. Thus, now I am steadfast in my belief in FORTH.

Screen 10 and 11 sets up the variables and the Columbia Mx964 hardware dependent words. The X-coordinate starts at the lower left corner as 0, far right as 1023, while Y = 0 starts at the lower left corner to the top as 779. Screen 12 to 14 defines the basic words, which draw the line, move the cursor, relative draw and move. Screen 15 defines the words to draw a square and the erasing of it. Screen 16 lets me draw many squares.

I know that there are still a lot of nice words that can be written, such as, to draw triangles, curve lines, etc. But, from this small exercise, I am totally convinced the FORTH is the one I will use from now on.

A VIDEO VERSION OF MASTER MIND

David Butler
Dorado Systems

The writing of this program served as my introduction to FORTH. Using the fig-FORTH Installation Manual, I stumbled my way through the basic concepts of FORTH and eventually arrived at this video Master Mind game. The game is derived completely from the original board version of Master Mind, therefore, all credit for the game itself goes to the Invicta Game Company.

The program contains many of the functions found in video editors, including cursor management and character collection. The sequence of this computer version of the game is as follows: After displaying the directions, the program prompts the player to enter his skill level. Then a 'secret code' is generated with the help of the player tapping the space bar. The screen is cleared, and a 'mask' of the Master Mind playing board is displayed. The cursor lands at the location where the player is to begin entering his guess. The program retains control of the cursor, responding to the player's key strokes. Backspacing and tabbing are allowed, en-

```
SCR # 18
  0 (  Master Mind in Forth by David A. Butler       DAB-17nov80 )
  1 -->
  2         David A. Butler
  3         33300 Mission Blvd
  4         Apt 126
  5         Union City, CA.  94587
  6         (415) 487-6039
  7
  8
  9 ***** A note about style:  If there is any, it is an accident.
 10       This was my first application in Forth, so it may lack
 11       some elegance.
 12
 13 ***** Requirements:  A video display 80 x 24 characters,
 14                      cursor addressing and clear screen
 15                      functions.
SCR # 19
  0 (  Master Mind         -notes-                   DAB-17nov80 )
  1 -->
  2      This is an implementation of Master Mind by Invicta.
  3 The game is very popular because it is easy to learn and a
  4 challenge to play.  There is a bit of luck to it, but it is
  5 mainly an exercise in logical deduction.  A "secret" code is
  6 generated, and it is "cracked" by analyzing a set of clues.
  7
  8      Those familiar with the original board game will have no
  9 difficulty adjusting to the computer version.  To newcomers,
 10 follow the directions carefully and you will have it in no
 11 time.  The Forth version is functionally identical to the
 12 board version.  It is written in fig-Forth, and has been run
 13 successfully on 6502, 8080, Z80, and 68000 processors.  It
 14 is a good demonstration program as well as an enjoyable game.
 15
SCR # 20
  0 (  Master Mind        set up some variables      DAB-17nov80 )
  1
  2 : TASK  ;  ( FORGETTABLE MARKER )
  3
  4 0 VARIABLE COLORS  28 ALLOT   COLORS 30 BLANKS
  5
  6 0 VARIABLE SCODE  2 ALLOT   0 VARIABLE GUESS 2 ALLOT
  7 0 VARIABLE SECRET  2 ALLOT
  8 0 VARIABLE BLACKER    0 VARIABLE WHITER
  9 6 VARIABLE #COLORS
 10
 11 3 VARIABLE CUR.ROW    23 VARIABLE CUR.COL
 12 1 VARIABLE XLOC   1 VARIABLE YLOC   0 VARIABLE DONE
 13 -->
 14
 15
SCR # 21
  0 (  Master Mind        set up - cont.             DAB-17nov80 )
  1
  2 : C.CONSTANT    ." YELLOWRED   BLACK GREEN WHITE BLUE        " ;
  3
  4 0 VARIABLE COLOR.KEY  6 ALLOT   ( "colors" table )
  5
  6 (  Use the sum of the ASCII code of the first 3 letters )
  7 (  i.e. BLUE = "B" + "L" + "U" = 66 + 76 + 85 = 227     )
  8
  9 234 COLOR.KEY  C!        219 COLOR.KEY 1+  C!
 10 207 COLOR.KEY 2 + C!     222 COLOR.KEY 3 + C!
 11 232 COLOR.KEY 4 + C!     227 COLOR.KEY 5 + C!
 12  96 COLOR.KEY 6 + C!
 13
 14  0 VARIABLE  #ATTEMPTS   ( used to keep score )
 15 -->
```

```
SCR # 22
  0 (  Master Mind        prompt and randomize        DAB-17nov80 )
  1 (  These definitions set the random values for the game  )
  2
  3 : NEWCOUNT ( [COLOR# + !]  )  DUP #COLORS @ <
  4     IF  1+   ELSE   DROP 1     THEN ;
  5
  6 : RAND   1 BEGIN NEWCOUNT ?TERMINAL UNTIL KEY DROP ;
  7
  8 : ASK.FOR.RANDOM   ." To randomize, tap space bar 4 times."
  9     4 0 DO RAND I SCODE + C! LOOP CR ;
 10
 11 : ASK.FOR.LEVEL
 12      CR ." Level 1 or 2 ?  " KEY DUP EMIT KEY EMIT
 13       50 = IF    7 #COLORS ! ELSE 6 #COLORS ! THEN CR ;
 14
 15 -->
SCR # 23
  0 (  Master Mind    translate color to numeric    DAB-17nov80 )
  1
  2 : COLOR.FIND       ( [COLOR#] ----[]  TYPES COLOR FROM #)
  3         1 - 6 * ' C.CONSTANT  3 + + 6 TYPE     ;
  4
  5 : TRANSLATE.CODE
  6          ( converts color # from SCODE to COLOR.KEY )
  7          ( numeric value in array "SECRET" )
  8  4 0 DO SCODE I + C@ 1 - COLOR.KEY + C@ SECRET
  9      I + C! LOOP   ;
 10
 11
 12
 13
 14 : J   R> R> R> [COMPILE]  R SWAP >R  SWAP >R  SWAP >R ;
 15 -->
SCR # 24
  0 (  Master Mind      cursor motion               DAB-17nov80 )
  1 (  Of course,  CRT dependent.  Here is Heath:           )
  2                        ( *** start CRT dependent words  *** )
  3 : CURSOR   ( [Y] [X]---[] ABSOLUTE CURSOR POSITION )
  4     31 + SWAP 31 + 89 27 EMIT EMIT EMIT EMIT ;
  5
  6 : CLEAR  ( CLEAR CRT SCREEN )  27 EMIT 69 EMIT   ;
  7
  8 : HOME   ( PUT CURSOR AT HOME  POSITION ) 0 0 CURSOR ;
  9                          (  ***  end of CRT dependent words  *** )
 10 : SHOW.COLORS  ( DISPLAY COLOR CHOICES )
 11    7 1 DO I 2 + 58 CURSOR I COLOR.FIND  LOOP
 12    #COLORS @ 7 = IF 9 57 CURSOR ." <BLANK>" ELSE THEN
 13    12 58 CURSOR  ." TAB between colors."
 14    13 58 CURSOR ." RETURN to set clues."  ;
 15 -->
SCR # 25
  0 (  Master Mind     board layout mask            DAB-17nov80 )
  1
  2 : BAR ." !" ;  : DASH ." _" ;  ( BOARD SYMBOLS )
  3 : TITLE   21 SPACES
  4     ." ====  M A S T E R  M I N D  ====" ;
  5 : DASHER  2 21 CURSOR BAR 32 0 DO ." ~" LOOP BAR CR ;
  6 : CLINE DUP 21 CURSOR BAR 54 CURSOR BAR ;
  7
  8 : SPACER 21 CURSOR ." !_^_______^_______^_______^______!" ;
  9 : CBLOCK  DUP CLINE 1+ SPACER ;
 10 : HIDDEN  3 23 CURSOR ." XXXXXX  XXXXXX  XXXXXX  XXXXXX"  ;
 11
 12 : DISPLAY.BOARD
 13   CLEAR  TITLE DASHER HIDDEN 24 3 DO I CBLOCK 2 +LOOP
 14       SHOW.COLORS ;
 15 -->
```

abling the player to keep changing his guess until he is satisfied that it is consistent with the clues he has thus far received. A correct guess is the result of the player's logical deduction (or very good luck) based on his previous clues. The directions on screen 31 explain the meaning of the two types of clues.

When the player signals he is ready, the program compares the player's guess to the secret code which was stored away earlier. Clues are generated and displayed, indicating to the player how close he is to the solution. The player has ten chances to deduce the secret code.

There are many improvements which could be made to this program to take advantage of more of FORTH'S built-in vocabulary -- most notably PAD and related words. For those short of memory, note that the directions could be shortened, left out, or read from disk with no change to the overall logic of the program.

Further notes and comments may be found in the source screens.

```
SCR # 26
  0 (  Master Mind      cursor tracking definitions  DAB-17nov80 )
  1
  2 : X    XLOC @ ;   : Y    YLOC @ ;
  3
  4 : XBUMP  X 52 =
  5     IF    23 DUP  CUR.COL !  XLOC !
  6      ELSE  1 XLOC +! X CUR.COL @ 8 + =
  7       IF X  CUR.COL ! THEN
  8      THEN  ;
  9
 10 : UNBUMPX X 23 = IF 52 XLOC !   ELSE -1 XLOC +! THEN ;
 11
 12 : TAB   CUR.COL  @ 47 =
 13     IF    23 CUR.COL !
 14    ELSE  8 CUR.COL +!
 15    THEN     CUR.COL @ XLOC !  DROP Y X CURSOR ; -->

SCR # 27
  0 (  Master Mind     character collection/editing  DAB-17nov80 )
  1 : BACKSPACE    X CUR.COL @ =
  2    IF DROP
  3     ELSE  UNBUMPX  Y X CURSOR SPACE Y X CURSOR DROP
  4      32 COLORS X + 23 - C!
  5     THEN   ;
  6
  7 : PROCESS    ( [CHAR] -- [] PROCESSES CHAR, MANAGES CURSOR )
  8    DUP EMIT COLORS X + 23 - C! XBUMP Y X CURSOR  ;
  9
 10 : GET.CHAR   KEY DUP 127 =
 11     IF     BACKSPACE ELSE DUP 9 =
 12       IF    TAB       ELSE DUP 13 =
 13         IF  1 DONE ! DROP
 14         ELSE PROCESS     THEN THEN THEN ;
 15 -->

SCR # 28
  0 (  Master Mind      guess / row section          DAB-17nov80 )
  1
  2
  3
  4 : INITIAL   2 * 3 + DUP YLOC ! CUR.ROW ! 23 23 XLOC
  5       ! CUR.COL ! Y X CURSOR
  6       30 0 DO 32 I COLORS + C! LOOP ;
  7
  8 : GET.COLORS   INITIAL 0 DONE ! BEGIN GET.CHAR DONE @ UNTIL ;
  9
 10 : PARSE.GUESS  4 0 DO I 8 * COLORS + C@
 11              I 8 * COLORS 1+ + C@
 12              I 8 * COLORS 2 + + C@
 13       + + I GUESS + C!  LOOP ;
 14 -->
 15

SCR # 29
  0 (  Master Mind    Clue generation                DAB-17nov80 )
  1
  2 : CLUE.CHECK
  3   0 BLACKER !    0 WHITER !   ( INITIALIZE COUNTS )
  4   4 0 DO
  5       SECRET I + C@    GUESS I + C@ =  ( CHECK FOR DIRECT HIT )
  6       IF    1 BLACKER +!    0 I GUESS + C!
  7    THEN  LOOP
  8    4 0 DO     GUESS I + C@  0   >   IF    ( IF NO HIT )
  9       4 0 DO
 10       GUESS I + C@  SECRET  J + C@ =  ( CHECK FOR WHITE )
 11       IF   1 WHITER +!     1 I GUESS + C!    LEAVE
 12       THEN
 13       LOOP  THEN
 14     LOOP  ;
 15 -->
```

```
SCR # 30
  0 (  Master Mind      present clues                  DAB-17nov80 )
  1
  2 : GIVE.CLUES   PARSE.GUESS   CLUE.CHECK
  3     Y 1 CURSOR  BLACKER @ . ." BLACK  "
  4                 WHITER  @ . ." WHITE  "   ;
  5 : UNMASK  3 23 CURSOR
  6    4 0 DO I SCODE + C@ COLOR.FIND I 3 =
  7     IF ."  " ELSE ."   " THEN LOOP 23 1 CURSOR ;
  8
  9 : ?AGAIN  20 58 CURSOR ." TYPE MASTER TO" 21 58 CURSOR
 10   ." PLAY AGAIN." UNMASK  23 1 CURSOR ;
 11 : LOSER     16 58 CURSOR ." NICE TRY BUT" 17 58 CURSOR
 12   ." NO CIGAR."   ?AGAIN  ;
 13 : WINNER   16 58 CURSOR ." PRECISELY. "  #ATTEMPTS ?
 14   ." TRYS."   ?AGAIN  ;
 15 -->

SCR # 31
  0 (  Master Mind   Directions to player           DAB-17nov80 )
  1
  2 : DIRECTIONS   CLEAR CR CR CR   CR  CR
  3 10 0 DO LOOP  ." Welcome to MASTER MIND."  CR CR
  4 ." The object of Master Mind is to break the secret code."
  5 CR ." The computer will pick the secret code, and you must"
  6 CR ." figure it out.  Two kinds of clues are given:" CR
  7 CR  ." (1)  # BLACK  means that you have # pegs correct " CR
  8     ."               in both color and position." CR CR
  9     ." (2)  # WHITE  means that you have # pegs of the " CR
 10     ."               correct color that are incorrectly " CR
 11     ."               placed. " CR  CR
 12 ." Be sure to spell the colors correctly.  You may tab amoung "
 13 CR ." the 4 positions until you've make your best guess." CR
 14 CR ." Type [RETURN] to receive clues." CR CR ." Good-luck."
 15   CR CR ;  -->

SCR # 32
  0 (  Master Mind      ++ FINAL ++                  DAB-17nov80 )
  1
  2
  3 : MASTER    DIRECTIONS   0 0  #ATTEMPTS  !
  4    ASK.FOR.LEVEL     ASK.FOR.RANDOM
  5    DISPLAY.BOARD     TRANSLATE.CODE ( put UNMASK to debug )
  6    0 10 DO
  7     1 #ATTEMPTS +!
  8     PARSE.GUESS  I GET.COLORS   GIVE.CLUES
  9     BLACKER @ 4 =
 10    IF WINNER LEAVE
 11     ELSE  THEN
 12    -1 +LOOP
 13    BLACKER @ 4 <
 14    IF LOSER ELSE THEN ;  MASTER
 15
```

```
                    ==== M A S T E R  M I N D ====
                   +-------+-------+-------+-------+
(These are hidden  | RED   | RED   | BLUE  | GREEN |
   during play)    +-^-----^-------^-------^-------+
                   +-^-----^-------^-------^-------+   YELLOW
                   +-^-----^-------^-------^-------+   RED
                   +-^-----^-------^-------^-------+   BLACK
                   +-^-----^-------^-------^-------+   GREEN
                   +-^-----^-------^-------^-------+   WHITE
                   +-^-----^-------^-------^-------+   BLUE
                   +-^-----^-------^-------^-------+
                   +-^-----^-------^-------^-------+
                   +-^-----^-------^-------^-------+
                   +-^-----^-------^-------^-------+
4 BLACK 0 WHITE    | RED   | RED   | BLUE  | GREEN |
                   +-^-----^-------^-------^-------+
1 BLACK 3 WHITE    | RED   | BLUE  | GREEN | RED   |
                   +-^-----^-------^-------^-------+
0 BLACK 4 WHITE    | BLUE  | GREEN | RED   | RED   |   PRECISELY.
                   +-^-----^-------^-------^-------+   4 TRIES
0 BLACK 1 WHITE    | YELLOW| GREEN | BLACK | WHITE |
                   +-^-----^-------^-------^-------+
```

(Snapshot of board after playing Master Mind)

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TRANSFER OF FORTH SCREENS BY MODEM

Guy T. Grotke
Forth Gear
San Diego, CA

Here is a simple but hopefully useful set of definitions for serial transfer of FORTH screens between machines. Several of us in the San Diego FIG are interested in sharing software, but we have been unable to do so because of all the different disk formats in use. While only a few had access to similar machines, we took a poll and found that more than 90% had RS-232 ports. The following two screens permit unidirectional transfer with a modem over telephone lines at 300 baud or hardwired at 19,200 baud. The definitions are not particularly sophisticated. There is no error checking or ack/nack with retry. Since it is source code which is being transferred, some editing will probably be necessary anyway, so such safeguards aren't worth the effort to write them.

There are four definitions which are entirely system dependent in each screen. These are SOUTPUT, COUTPUT, SINPUT, and CINPUT. Respectively, they direct output to the serial port, output to the console, input from the serial port, and input from the console. If your system doesn't use I/O flags or vectors, you may have to write serial port drivers and point KEY and EMIT to them for SOUTPUT and SINPUT. In screen 80, these four words are defined for an APPLE running a serial interface in slot two (driver at $C200). In screen 58, they are defined for an Ohio Scientific with the normal serial port found in the personal models. These are examples of vectored and flagged I/O redirection.

The remaining definitions should be quite universal among fig (and other) systems. Screen 80 contains all that is necessary to receive screens under the control of the sender. FINISHED and RECEIVE simply redirect input and output. The word P redefines the fig editor word P to do the same thing except with I/O redirection. Note that these three definitions are simple and fool-proof enough that they could be sent to another computer if that computer was first told to accept all input from the serial transfer line. Once these definitions were compiled by the receiving system, screen transfer could begin. In screen 58, the word WAIT waits for anything to be sent back from the receiver with a carriage return on the end. The word OK is defined just in case the receiver sends one or more OK's back to the sender during transfers. SEND-SCREEN will send a screen to the receiver, one line at a time, by emulating a user entering lines with the receiver's line editor. First SEND-SCREEN asks the receiver to list the screen being sent. This insures that the proper disk blocks are resident. After the LIST, the receiver will reply "OK" followed by a carriage return. WAIT makes the transmitter wait for this carriage return. This is the only handshaking needed. Each line's text is sent preceded with the letter P and a space, and followed by a carriage return. WAIT causes the transmitter to wait for the receiver to reply "OK" after each line is sent. SEND is a multi-screen transmitter. Note that the range of screens received and recorded on disk will correspond exactly to the screen numbers sent. If that is inconvenient, a variable containing an offset or starting receiver screen number could be added.

The proof that it works is before you: the different screen formats and distant screen numbers reflect the fact that screen 58 was written on my OSI and sent to my APPLE to be printed. I have used these definitions to send a 6502 assembler, a database manager, and several hundred data entries between my machines with no trouble.

```
SCR # 58
  0 ( Serial Screen Transfer -- sending          GTG 7-02-81
  1  HEX
  2  : SOUTPUT 3 2322 C! ;       ( SEND OUTPUT TO SERIAL + CONSOLE
  3  : COUTPUT 2 2322 C! ;       ( SEND OUTPUT ONLY TO CONSOLE
  4  : SINPUT  1 2321 C! ;       ( GET INPUT FROM SERIAL
  5  : CINPUT  2 2321 C! ;       ( GET INPUT FROM CONSOLE
  6  : SOUT SOUTPUT CINPUT ;     : SIN COUTPUT SINPUT ;
  7  : OK ;                      : WAIT SIN QUERY ;
  8  : SEND.SCREEN                          ( SCR# --> nothing left
  9     SOUT DUP . ." COUTPUT LIST SOUTPUT " CR WAIT
 10     10 0 DO I SOUT  . ." P " I OVER  .LINE  CR
 11     WAIT  CINPUT  ?TERMINAL IF LEAVE THEN LOOP ;
 12  : SEND              ( FIRST SCR# / LAST SCR# --> nothing left
 13     1+ SWAP DO I SEND.SCREEN ?TERMINAL IF  LEAVE THEN LOOP
 14     SOUT CR  WAIT SOUT  ." FINISHED " CR  COUTPUT  ;
 15  DECIMAL  ;S
```

```
SCR # 80
  0 ( CONSOLE/SERIAL I/O        )
  1  FORTH DEFINITIONS  HEX
  2  : UNLINK FDF0 36 !  FD1B 38 ! ;
  3  : SOUTPUT C200 36 !    ;
  4  : COUTPUT FDF0 36 ! ;
  5  : SINPUT C200 38 ! ;
  6  : CINPUT FD1B 38 ! ;
  7
  8 EDITOR DEFINITIONS
  9
 10  : FINISHED CINPUT COUTPUT FLUSH ;
 11  : P COUTPUT P SOUTPUT ;
 12  : RECEIVE COUTPUT SINPUT ;
 13 FORTH DEFINITIONS EDITOR
 14 DECIMAL
 15  ;S
```

HELP WANTED

Part-time - New York-New Jersey Area

Assist internationally known sound artist, Max Neuhaus, develop additional software for micro computer controlled sound synthesis system. FORTH controlling 32 synthesizers from CRT Light Pen Terminal.

Moderate fees, travel possibilities, hardware experience preferred.
Send information or resume to:
Max Neuhaus
210 5th Avenue
New York, NY 10010

Independent FORTH programmers to implement Marx FORTH for TRS-80, Apple, CP/M and other systems. Royalties paid for best implementation with most enhancements. Great opportunity for the competitive programmer who, like me, would like to make a living at home and not have to move to California to do it.
Contact:
Marc Perkel
Perkel Software Systems
1636 N. Sherman
Springfield, MO 65803
(417) 862-9830

PRODUCTS REVIEW

SORCERER-FORTH
by Quality Software

For about a year, I have been using an excellent version of fig-FORTH tailored for the Exidy Sorcerer. It is a product of Quality Software, 6660 Reseda Blvd., Suite 105, Reseda, CA 91335.

FORTH for the Sorcerer implements Release 1.1 of 8080 fig-FORTH. It includes a full screen editor and input/-output routines for the keyboard, screen, and both serial and Centronics printers. The Sorcerer's excellent graphics are also available.

Disc storage is simulated in RAM. A 32 K Sorcerer can hold 14 screens--with 48 K, up to 30 screens. Tape-handling routines are provided, to move data to and from the simulated disk space. The CP/M disk interface routines are present, but not implemented.

One of the nicest features of Quality Software's FORTH is its documentation. The 126-page manual is well-written, and relatively complete. It includes sufficient information for a FORTH neophyte, though it does not delve too deeply into system operations.

Quality Software permits--even encourages--users to market application programs incorporating Sorcerer FORTH. They do ask that written permission be obtained frist, but promise that permission will normally be granted after review of a sample of the program.

I highly recommend this excellent product, and ask that you include it in your periodic listing of available software.

C. Kevin McCabe
1560 N. Sandburg Terr. #4105
Chicago, IL 60610
(312) 664-1632

A COMPARISON OF TRANSFORTH WITH FORTH
Insoft
Medford, OR

A question we've been hearing a lot lately is "How does TransFORTH compare with fig-FORTH?" In structure, TransFORTH is similar to most version of FORTH, but is is not a FORTH-79 Standard System. The major differences are outlined in this paper.

Floating-point numbers

In TransFORTH, the stack itself contains floating-point numbers, with 9 digits of accuracy. No special sequences are required to retrieve floating-point values. Words are available for storing or retrieving single bytes and two-byte cells, but all values are stored on the stack in floating-point format. Numbers can be as large as 1E38, and as small as 1E-38.

Transcendental functions

The floating-point format mentioned above makes TransFORTH a natural language for transcendental functions. Functions included in the system which are not found in most versions of FORTH include: sine, cosine, tangent, arctangent, natural logarithm, exponential, square root, and powers.

Data structures

TransFORTH contains words that will store or fetch 5-byte floating-point values, 2-byte cells, and single bytes from any location in memory. TransFORTH does not have the fig-FORTH <BUILDS, DOES> construction, but instead uses a powerful built-in array declaration. Arrays can either fill space in the dictionary, or be located absolutely in memory. Arrays with any number of dimensions may be declared, and each dimension can have any length, within the limits of available memory.

Strings

Strings are merely arrays (of any dimension and size) with an element length of one. Each character occupies one byte, i.e., one element of the array. Built-in string functions included.

Disk access and the editor

TransFORTH does not use the virtual memory arrangement found in most versions of FORTH. Instead a standard DOS 3.3 format is used, and files are called from the disk by name.

TransFORTH includes a straightforward line-based text editor. The editor is not added to the dictionary as a list of defined words, but is included as a separate module callable from TransFORTH. DOS text files are used for saving source files. This means that any text editor that uses DOS text files may be used for editing TransFORTH programs. In addition, TransFORTH program data may be shared with other programs and languages.

Grahics

Two graphics utilities along with a couple of graphics demo programs are included on the system diskette. One utility contains high-resolution graphics and Turtlegraphics commands, and the other has low resolution graphics commands. The graphics capabilities are added to the system by compiling these utilities into the dictionary. The hi-res package includes a call to a module which allows text and graphics to appear together anywhere on the screen.

Vocabulary

TransFORTH is a single-vocabulary system. Related programs can be grouped together in disk files, rather than in separate vocabularies. (Multiple vocabularies find their most usage in multi-user systems.)

Compilation and speed

All entries in TransFORTH are compiled directly into 6502 machine language for greater speed. No address interpreter is used. Even immediate keyboard entries are compiled before being executed. This means that routines can be tested at the keyboard for speed before being added as colon definitions.

TransFORTH is fast. It is not as fast an integer versions of FORTH, because it handles 5 bytes with every stack manipulation instead of two. TransFORTH programs will run faster than similar Applesoft programs, and show a great increase in speed when longer programs are compared.

While TransFORTH works much like Fig-FORTH, the differences between the two become readily apparent under closer examination. FORTH programmers will pick up TransFORTH with little trouble, but nearly all FORTH programs will require translation into TransFORTH to take advantage of its powerful features. These features are accessible with a minimum of work from the user, bringing a FORTH-like environment into the realm of practical scientific and business programming for the first time.

EDITOR'S RESPONSE TO TRANSFORTH

The above material is extracted from explanatory sales material from the program vendor. Commentary we have indicated from TransFORTH users can be summarized:

1. This implementation should be named as one of the CONVERS group of languages, as it compiles to assembly language rather than threaded code.
2. It is easier to add floating point math to FORTH, than to alter TransFORTH to use integers for execution speed improvements. Why not both?
3. If the implementor had done his DOS 3.3 interface using the standard FORTH word BLOCK, an immense gain in value would result. Direct access and DOS compatibility.
4. <BUILDS DOES> probably could be added but apparently the implementor doesn't know how or chooses to deprive his customers of this powerful structure. Arrays are definitely not equivalent technically or philosophically.

In conclusion, it appears that TransFORTH is a reverse POLISH BASIC, with names rather than labels. A small amount of additional effort would have built upon FORTH, rather than strip out major attributes.--ed.

NEW PRODUCTS

FLEX-FORTH

Complete compiler/interpreter, assembler, editor, operating system for:

APPLE II computers	$25.00
KIM computers	$21.00

FLEX-FORTH is a complete structured language with compiler, interpreter, editor, assembler and operating system for any APPLE II or APPLE II+ computer with 48K and disk or KIM with 16K of memory. Most application programs run in less than 16K starting at 1000 HEX and often as little as 12K, including the FLEX-FORTH system, itself.

This is a full-featured FORTH following the F.I.G. standard, and contains a 6502 assembler for encoding machine language algorithms if desired. The assembler permits macros BEGIN...UNTIL, BEGIN...AGAIN, BEGIN...WHILE...REPEAT, IF...ENDIF, and IF...ELSE...ENDIF. Editor and virtual memory files are linked to the Apple DOS 3.2. An application note for upgrading to DOS 3.3 is included. Object code on disk with user manual sells for **$25.00.** (APPLE) or on cassette with user manual for **$21.00** (KIM).

A complete source listing is available to purchasers of FLEX-FORTH for **$20.00.** The source is valuable in both showing how FORTH works and in giving examples of FORTH code and integrated assembly code.

Order from: GEOTEC, 1920 N. W. Milford Way, Seattle, WA 98177. Be sure to specify machine.

MARX FORTH V1.1

Perkel Software Systems
1636 N. Sherman
Springfield, MO 65803
(417) 862-9830

Enhanced Z80 fig-FORTH implemented for Northstar System enhancements include link fields in front of name for fast compile speed; dynamic vocabulary relinking; case; arguments-results with 'to' variables: and more. 79-Standard package includes easy to use screen editor.

Price: $75.00

Smart assembler, meta-compiler and source code (in FORTH) sold separately. Call for information.

TWO NEW PRODUCTS FROM LAXEN AND HARRIS, INC.

Laxen and Harris, Inc.
24301 Southland Drive
Hayward, CA 94545
(415) 887-2894

1. Working FORTH
Release 2.1

"Starting FORTH" compatible FORTH software for a 8080 or Z80 computer system with the CP/M (TM) operating system.

This FORTH implementation is compatible with the popular book "Starting FORTH" by Leo Brodie. It is intended to be a companion to the book to aid learning FORTH. It is also a complete environment for developing and executing FORTH programs. It contains:

Compilers
Disk operating system
Full names stored, up to 31 characters
String handling
Enhanced error checking
16-bit and 32-bit integer arithmetic and input/output

This is a single-user, single-task system which is not ROM-able as supplied. Floating point arithmetic and CP/M file access are not supported.

This system as supplied runs comfortably in a 8080 or Z80 computer system with at least 32K bytes of RAM memory, at least one floppy disk drive (8" single density, single sided, soft sectored format is assumed), and the "BIOS" part of the CP/M operating system. The use of a printer is supported but not required. This software may be easily modified to use other memory sizes or disk formats. It requires 14K bytes of memory which includes 4K bytes of disk buffers.

This FORTH system was adapted from the fig-FORTH model but is not fully compatible with that language dialect. It is also not fully compatible with the FORTH-79 Standard. The three dialects are similar, but the Starting-FORTH version has advantages over the other two.

Price: $33.00 - plus $2.00 - Postage and Handling

CP/M is a registered trademark of Digital Research, Inc.

2. Learning FORTH

Learning FORTH is a computer aided instruction package that interactively teaches the student the fundamentals of the FORTH programming language and philosophy. It consists of a set of FORTH screens that contain program source code and instruction text. It is based on the book, "Starting FORTH," by Leo Brodie. It will run with any Starting FORTH compatible system, as well as fig-FORTH system. The manual is only one page long and describes how to load the system. After that, everything is self explanatory. It is supplied on 8" single density diskettes in IBM 3740 format. **The price is $33.00** if ordered together with the Working FORTH Disk. Please add $2.00 for shipping and handling, and allow at least 3 weeks for delivery.

Note: Buy both for $55.00 plus $2.00 postage and handling.

POLYMORPHIC FORTH

Abstract Systems, etc.
1686 West Main Road
Portsmouth, RI 02871
(401) 683-0845
Ralph E. Kenyon, Jr.

Product Description: FORTH (PolyMorphic fig-FORTH 1.1.0). 8080 fig-FORTH 1.1 without asmb. or Editor (uses PolyMorphic resident editor.)

A demo application which computes a table of values for a general quadratic equation is included.

PolyMorphic Systems 8813, 8810 needs only 16K. Documentation on FORTH not included.

Manual: documentation covers particular implementation details for fig-FORTH to interface to the PolyMorphic Systems Microcomputer. Sorted VLIST included.

Implementation document available separately. Separate document available for cost of postage. Product data available on PolyMorphic SSSD 5" diskette format. 4 copies sold to date. **Price: $40.00,** includes shipping, diskette, (R.I. residents add 6% sales tax). Warranty limited to replacement of a diskette damaged in shipment. (We'll try to fix any bugs discovered.) Orders shipped out within 3 days of receipt (usually next day).

HEATH H89 FORTH

MCA
8 Newfield Lane
Newtown, Conn. 06470

MCA announces the availability of FORTH for the Heath H89 computer. MCA FORTH is 8080 fig-FORTH V1.1 configured to run on a single disk H89 with 32K or more of memory, utilizing HDOS 1.6 or later.

MCA FORTH provides the standard FORTH facilities plus the following special features: HDOS file manipulation capability, a control character to restart FORTH (recover from loops), on-line tailoring of FORTH facilities (e.g., number of disk buffers), ability to hook to separately assembled routines, and use of Heath DBUG.

Items supplied with FORTH include the fig-Editor, an 8080 structured assembler, and two games provided as examples of FORTH programming.

The documentation supplied with MCA FORTH is suitable for experienced FORTH programmers; however, a bibliography of documentation for beginners is provided.

MCA FORTH is available from MCA on a 5-1/4" disk for $25 including documentation. Documentation is available for $4.00. (Conn. residents please add sales tax).

NEW PRODUCTS FROM INNER ACCESS CORPORATION

1. Fig-FORTH compiler/interpreter for PDP-11 for RT11, RSX11M or standalone with source code in native assembler. Included in this package are an assembler and editor written in FORTH and installation documentation. **Price: $80.00**

   This is available on a one 8" single density diskette only.

   Reference Manual for PDP-11 fig-FORTH above. **Price: $20.00**

2. Fig-FORTH compiler/interpreter for CP/M or CROMEMCO CDOS system comes complete with source code written in native assembler. Included in this package are an assembler and editor written in FORTH and installation documentation. **Price: $80.00**

   All diskettes are single density, with 5-1/4" diskettes in 128 byte, 18 sector/-track format and 8" diskettes in 128 byte, 26 sector/track (IBM) format.

   Released on two 5-1/4" diskettes with source in 8080 assembler.

   Released on one 8" diskette with source in 8080 assembler.

   Released on two 5-1/4" diskettes with source in Z80 assembler.

   Released on one 8" diskette with source in Z80 assembler.

   Manual for CP/M (or Cromemco) fig-FORTH above. **Price: $20.00**

3. METAFORTH™ Cross-compiler for CP/M or Cromemco CDOS to produce 79-Standard FORTH on a target machine. The target can include an application without dictionary heads and link words. It is available on single density diskettes with 128 byte 26 sector/track format. Target compiles may be readily produced for any of the following machines:

   CROMEMCO-all models
   TRS80 Model II under CP/M
   Northstar Horizon
   Prolog Z80

   Released on two 5-1/4" diskettes or on one 8" diskette.

   Price: $450.00

4. Complete Zilog (AMD) Z8002 development system that can be run under CP/M or Cromemco CDOS. System includes a METAFORTH™ cross compiler which produces a Z8002 79-Standard FORTH compiler/interpreter for the Zilog Z8000 Development Module. Package includes a Z8002 assembler, a Tektronix download program and a number of utilities.

   Released on two 5-1/4" diskettes or on one 8" diskette.

   Price: $1,450.00

5. Zilog Z8002 Development Module fig-FORTH ROM set. Contains 79-Standard FORTH with Z8002 assembler and editor in 4 (2716) PROMS. **Price: $280.00**

CODE9

Arthur M. Gorski
2240 S. Evanston Avenue
Tulsa, OK 74114
(918) 743-0113

CODE9 is a M6809 Assembler for use with any fig-FORTH system. It features all M6809 addressing modes except long relative branch instructions. It performs syntax error checking at assembly time. Memory requirements: 4.75K bytes free RAM above FORTH. CODE9 is distributed as a commented source listing and manual. **Price: $20.00**

PET-FORTH

by

Datatronic AB
Box 42094
S-126 12 Stockholm
Sweden
(0)-8-744 59 20
Peter Bengtson

Product Description: Extended fig-FORTH for the Commodore CBM/PET computer series.

Screen editor, utilizing the special CBM screen editing possibilities for compactness and ease of use, macro-assembler, double-precision extensions, CRT handling, random numbers, real-time clock, a very complete string package, IEEE control words, integer trig functions.

An expansion disk (coming soon) will contain floating point arithmetic including complex numbers, transparent overlay control words for data and program segments, a file system, and more. A METAFORTH compiler will shortly be available.

Runs on CBM 8032 plus an 8050 dual disk drive. Other configurations coming: 4032, 4040, VIC, and MicroMainFrame.

8032 version runs in 32K only. 4032 versions will run in either 16 or 32K.

Manual Description: 322 pages, including all source code.

Complete introduction to FORTH. Special chapters cover the asembler, <BUILDS and DOES>, IEEE handling, strings etc.

Manual is available separately.

Separate purchase price is $40.00. This is not creditable towards later purchase.

Product/Ordering Data: Shipped as diskette and an accompanying security ROM, holding part of the Kernel.

Currently, there are approximately 75 installations, after 2 months on the market.

Price: $290.00 Includes diskette, ROM, manual, shipping and taxes.

PET-FORTH, as all other Datatronic software, carries a life-time guarantee. All future versions will be distributed to the registered owners without any cost whatsoever.

Delivery is immediate.

US dealers are invited. UK sole distributor is Petalect Electronic Services Ltd, 33/35 Portugal Road, Woking Surrey. You may also order directly from us.

Diskette of FORTH Application Modules

from
Timin Engineering Company
9575 Genessee Avenue, Ste. E-2
San Diego, CA 92121
(714) 455-9008

The diskette of FORTH application modules, a new product by Timin Engineering, is a variety package of FORTH source code. It contains hundreds of FORTH definitions not previously published. Included on the diskette are data structures, software development aids, string manipulators, an expanded 32-bit vocabulary, a screen calculator, a typing practice program, and a menu generation/selection program. In addition, the diskette provides examples of recursion, <BUILDS...DOES> usage, output number formatting, assembler definitions, and conversational programs. One hundred screens of software and one hundred screens of instructional documentation are supplied on the diskette. Every screen is in exemplary FORTH programming style.

The FORTH screens, written by Scott Pickett, may be used with Timin FORTH or other fig-FORTH. **The price for the diskette of FORTH application modules is $75.00 (if other than 8" standard disk, add $15.00).** To order the FORTH modules, write Timin Engineering Company, 9575 Genesee Avenue, Suite E-2, San Diego, CA 92121, or call (714) 455-9008.

AUDIO TAPES OF 1980 FORML CONFERENCE AND 1980 FIG CONVENTION

1. FORTH-79 Discussion, 200 min. **Price: $35.00**
2. Purpose of FIG, 37 min. **Price: $10.00**
3. Charles Moore, 63 min. **Price: $15.00**
4. FORTH, Alan Taylor, 47 min. **Price: $15.00**

Complete set $65.00

edu-FORTH
1442-A Walnut Street, #332
Berkeley, CA 94709

The following vendors have versions of FORTH available or are consultants. (FIG makes no judgment on any products.)

ALPHA MICRO

Professional Management Services
724 Arastradero Rd. #109
Palo Alto, CA 94306
(415) 858-2218

Sierra Computer Co.
617 Mark NE
Albuquerque, NM 87123

APPLE

IDPC Company
P. O. Box 11594
Philadelphia, PA 19116
(215) 676-3235

IUS (Cap'n Software)
281 Arlington Avenue
Berkeley, CA 94704
(415) 525-9452

George Lyons
280 Henderson St.
Jersey City, NJ 07302
(201) 451-2905

MicroMotion
12077 Wilshire Blvd. #506
Los Angeles, CA 90025
(213) 821-4340

CROSS COMPILERS

Nautilus Systems
P.O. Box 1098
Santa Cruz, CA 95061
(408) 475-7461

polyFORTH

FORTH, Inc.
2309 Pacific Coast Hwy.
Hermosa Beach, CA 90254
(213) 372-8493

LYNX
3301 Ocean Park #301
Santa Monica, CA 90405
(213) 450-2466

M & B Design
820 Sweetbay Drive
Sunnyvale, CA 94086

Micropolis

Shaw Labs, Ltd.
P. O. Box 3471
Hayward, CA 94540
(415) 276-6050

North Star

The Software Works, Inc.
P. O. Box 4386
Mountain View, CA 94040
(408) 736-4938

PDP-11

Laboratory Software Systems, Inc.
3634 Mandeville Canyon Rd.
Los Angeles, CA 90049
(213) 472-6995

OSI

Consumer Computers
8907 LaMesa Blvd.
LaMesa, CA 92041
(714) 698-8088

Software Federation
44 University Dr.
Arlington Heights, IL 60004
(312) 259-1355

Technical Products Co.
P. O. Box 12983
Gainsville, FL 32604
(904) 372-8439

Tom Zimmer
292 Falcato Dr.
Milpitas, CA 95035

1802

FSS
P. O. Box 8403
Austin, TX 78712
(512) 477-2207

6800 & 6809

Kenyon Microsystems
1927 Curtis Avenue
Redondo Beach, CA 90278
(213) 376-9941

TRS-80

The Micro Works
P. O. Box 1110
Del Mar, CA 92014
(714) 942-2400

Miller Microcomputer Services
61 Lake Shore Rd.
Natick, MA 01760
(617) 653-6136

The Software Farm
P. O. Box 2304
Reston, VA 22090

Sirius Systems
7528 Oak Ridge Hwy.
Knoxville, TN 37921
(615) 693-6583

6502

Eric C. Rehnke
540 S. Ranch View Circle #61
Anaheim Hills, CA 92087

Saturn Software, Ltd.
P. O. Box 397
New Westminister, BC
V3L 4Y7 CANADA

8080/Z80/CP/M

Laboratory Microsystems
4147 Beethoven St.
Los Angeles, CA 90066
(213) 390-9292

Timin Engineering Co.
9575 Genesse Ave. #E-2
San Diego, CA 92121
(714) 455-9008

Application Packages

InnoSys
2150 Shattuck Avenue
Berkeley, CA 94704
(415) 843-8114

Decision Resources Corp.
28203 Ridgefern Ct.
Rancho Palo Verde, CA 90274
(213) 377-3533

68000

Emperical Res. Grp.
P. O. Box 1176
Milton, WA 98354
(206) 631-4855

Firmware, Boards and Machines

Datricon
7911 NE 33rd Dr.
Portland, OR 97211
(503) 284-8277

Forward Technology
2595 Martin Avenue
Santa Clara, CA 95050
(408) 293-8993

Rockwell International
Microelectronics Devices
P.O. Box 3669
Anaheim, CA 92803
(714) 632-2862

Zendex Corp.
6398 Dougherty Rd.
Dublin, CA 94566

Variety of FORTH Products

Interactive Computer Systems, Inc.
6403 Di Marco Rd.
Tampa, FL 33614

Mountain View Press
P. O. Box 4656
Mountain View, CA 94040
(415) 961-4103

Supersoft Associates
P.O. Box 1628
Champaign, IL 61820
(217) 359-2112

Consultants

Creative Solutions, Inc.
4801 Randolph Rd.
Rockville, MD 20852

Dave Boulton
581 Oakridge Dr.
Redwood City, CA 94062
(415) 368-3257

Go FORTH
504 Lakemead Way
Redwood City, CA 94062
(415) 366-6124

Inner Access
517K Marine View
Belmont, CA 94002
(415) 591-8295

John S. James
P. O. Box 348
Berkeley, CA 94701

Laxen & Harris, Inc.
24301 Southland Drive, #303
Hayward, CA 94545
(415) 887-2894

Microsystems, Inc.
2500 E. Foothill Blvd., #102
Pasadena, CA 91107
(213) 577-1471

FORTH INTEREST GROUP
MAIL ORDER

	USA	FOREIGN AIR
☐ Membership in FORTH INTEREST GROUP and Volume III (6 issues) of FORTH DIMENSIONS.	$15	$27
☐ Volume II of FORTH DIMENSIONS (6 issues)	$15	$18
☐ Volume I of FORTH DIMENSIONS (6 issues)	$15	$18
☐ fig-FORTH Installation Manual, containing the language model of fig-FORTH, a complete glossary, memory map and installation instructions	$15	$18
☐ Assembly Language Source Listings of fig-FORTH for specific CPU's and machines. The above manual is required for installation. Check appropriate box(es). **Price per each.**		
☐ 1802 ☐ 6502 ☐ 6800 ☐ 6809 ☐ 8080 ☐ 8086/8088 ☐ 9900 ☐ APPLE II ☐ PACE ☐ ALPHA MICRO ☐ PDP-11 ☐ NOVA	$15	$18
☐ "Starting FORTH" by Brodie. BEST book on FORTH. (Paperback) ***NEW***	$16	$20
☐ "Starting FORTH" by Brodie. (Hard Cover) E	$20	$25
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