Use the Forth

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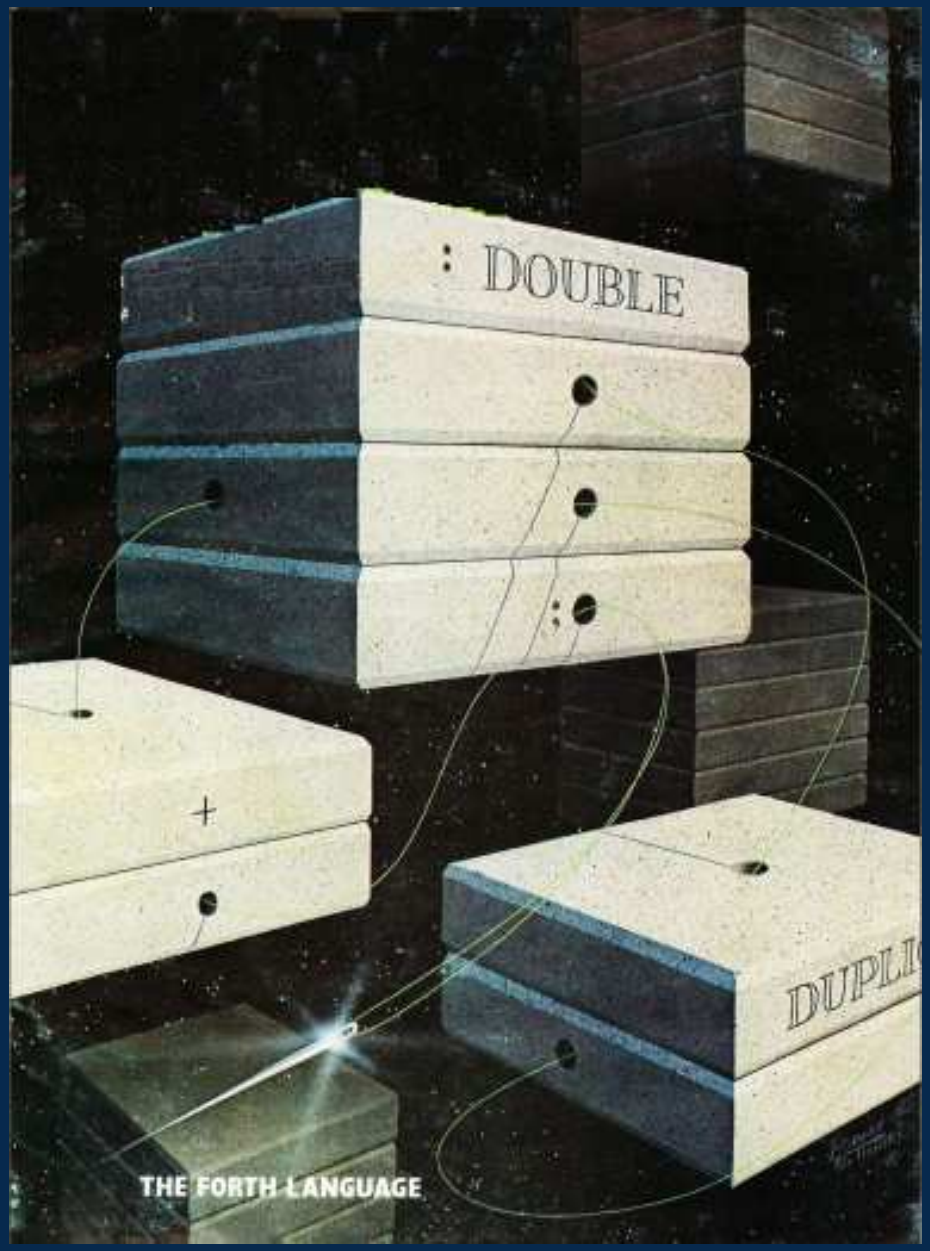


Charles Moore: Creator of Forth

I like the observation that Forth is an amplifier: a good programmer can write a great program; a bad programmer a terrible one. I feel no need to cater to bad programmers.

(Charles H. Moore)

izquotes.com

Forth Background

- Developed on IBM 1130 at NRAO
- Major Applications:
  - Optical and radio telescope control
  - Satellite and space exploration systems
  - Large LASER array control
  - OpenBoot: Sun, IBM, Apple, ARM, OLCP XO-1
  - FreeBSD boot loader
  - Canon Cat
  - Jupiter ACE
  - Available for almost every small computer

Forth Background

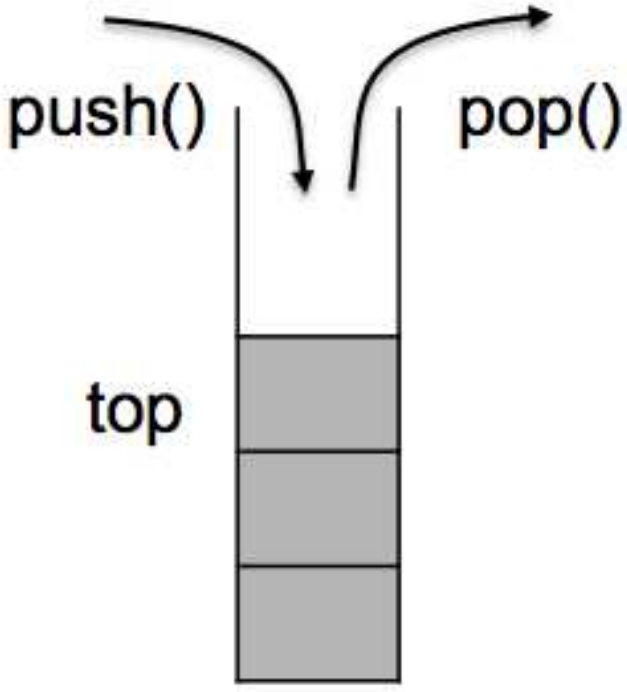
- "Standards:"
  - figForth
  - Forth-79
  - Forth-83
  - ANS Forth (ANSI '94)
- Forth processors
  - Harris RTX-2010
  - F21
  - PSC 1000
  - Novix NC4000
  - SEAforth24 and 40
  - GA 144

Forth Syntax

NONE!

- Words separated by spaces

Stack



stack

- Defined by `push()` and `pop()` operations
- Last in-First out (LIFO) structure

Forth Stack Use

- Numbers get pushed
- Words pop arguments and push results
- Examples
  - `3 .`
  - `3 5 .`
  - `3 5 + .`
  - `3 5 XOR .`

Basic Stack Operations

- `.` — Pop and print the top of the stack
- `+ - * / MOD ABS` — Usual arithmetic operations
- `MINUS` — Unary negation
- `AND OR XOR` — Bitwise Boolean operations

Stack Manipulations

- `DUP` — Duplicate top of stack
- `DROP` — Pop and discard top of stack
- `SWAP` — Pop top two numbers and push in reverse
- `ROT` — Remove third element and push it on top
- `OVER` — Copy second element and push
- `!` — Store second value at address on top
- `@` — Fetch: pop address and push contents of the address

Number Bases

- `DECIMAL` — Switch to base 10
- `HEX` — Switch to base 16
- `BASE` — Variable holding current base
- Example:
  - `5 BASE !` — Set to base 5

Defining New Words

- `: ... ;` — Define a new executable word
- `VARIABLE` — Create a variable and word to address it
- `CONSTANT` — Create a named constant
- `VLIST` — Print a list of defined words
- Examples:
  - `: SQ DUP * ;` — Define a function to computer the square of the top of the stack
  - `VARIABLE TEMP` — Create a variable called `TEMP`
  - `5 CONSTANT FIVE` — Give the number 5 the name `FIVE`
  - `FIVE TEMP !` — Store 5 into the variable `TEMP`
  - `TEMP @ BASE !` — Use the value of `TEMP` to set the number base

Control Flow

- `IF ... THEN` — Simple condition
- `IF ... ELSE ... THEN` — Two-way branch
- `DO ... LOOP` — Count by 1 loop
- `DO ... +LOOP` — Arbitrary increment loop
- `I` — Push loop counter onto stack
- `BEGIN ... UNTIL` — Post-test loop
- `BEGIN ... WHILE ... REPEAT` — Pre-test (mid-test) loop

Examples

- `: IFACT 1+ 1 SWAP OVER DO I * LOOP ;`
- `: GCD BEGIN SWAP OVER MOD DUP 0= UNTIL DROP ;`
- ```
  : RFACT [ SMUDGE ] DUP 0= IF DROP 1 ELSE
      DUP 1- RFACT * THEN [ SMUDGE ] ;
  ```
  ```

A Little Bigger Example

- Find all 3-digit numbers that are equal to the sum of the cubes of the digits

```
– : CUBE DUP DUP * * ;
– : DIGITS DUP DUP 100 / ROT 10 MOD ROT
      10 / 10 MOD ROT ;
– : 3CUBES CUBE ROT CUBE ROT CUBE ROT ;
– : CUBIES 1000 100 DO I DIGITS 3CUBES + +
      I = IF I . CR THEN LOOP ;
```