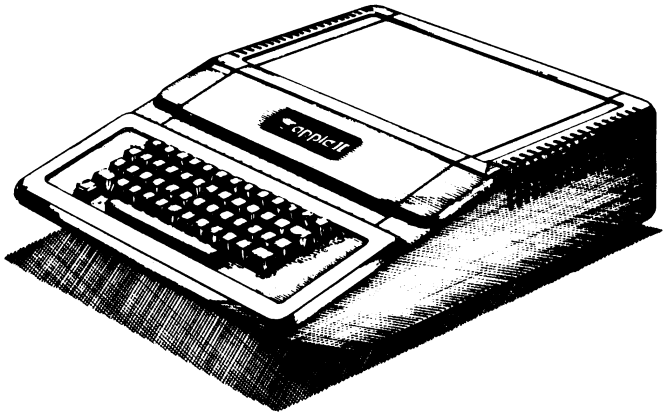
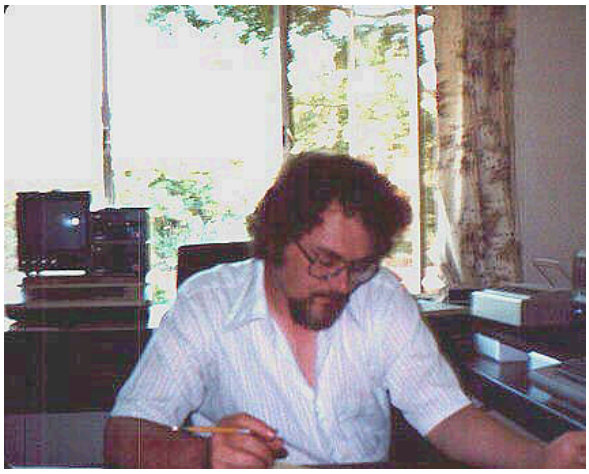
Apple II Computer Technical Information



Apple Computer: The Early Days A Personal Perspective
(or Early Apple History and the development Apple DOS)

Source:
http://www.laughton.com/Apple/Apple.html
22 December 2000



Paul in his home office. Behind him is his Apple II system. The system was hand delivered to Paul by Steve Jobs for use in the development projects talked about below. The Disk II disk drives with the are serial numbered 3 and 4.

In 1977, I became very excited about these new microcomputers. I had been working as a systems programmer on large IBM main frames (for IBM) for eight years. IBM's operating systems had become huge (many megabytes!). It had become so large that no one person could understand it all. The limited address space (64k) and possibility of owning my very own personal computer was very exciting. One day while visiting the Byte Shop (the first personal computer store), I came across a brochure and order form for the new Apple II computer. It was truly amazing. I had to have one. Coincidental to this, I happen to see a small add in the paper from a company called Shepardson Microsystems. They were looking for a programmer. On a lark, I sent them my resume. A few days later I went for an interview. I learned that Bob Sephardson had just signed a contract with Apple Computer to write a Basic Interpreter. He offered me the job of writing it.

[FIGURE] Brochure and order form for the new Apple II computer:

THE OFFER

We expect a sizable backlog of orders almost immediately after APPLE-II is nationally announced in April. This advance offer is extended to allow you to order an Apple-II from the first production run, thus be guaranteed delivery by April 30, 1977. The terms of the advance order are as follows:

1. All orders will be processed on a first-come, first-served basis regardless of quantity.
2. A deposit of one-third (1/3) of the total dollar amount ordered will be required and must accompany the order, the balance due on delivery.
3. All California residents must add 6½% sales tax on retail orders.
4. Apple will pay all shipping (UPS) and order handling charges.
5. Delivery is guaranteed on or before April 30, 1977.

The only other items required to start using your APPLE-II are:

- An ASCII encoded keyboard.
- A video monitor (or home TV with RF modulator).
- A power supply:
  5v @ 2A
  12v @ 1.5A
  −5v @ .5A
  −12v @ .5A
  (These current requirements will supply a totally loaded Apple-II with 8 peripheral boards!)
- Case (optional).

All four items above will be available from Apple in April. Check with us for prices.

PRICES

APPLE-II board, completely assembled & tested with 4k bytes RAM	$600.00
Additional RAM: each 4k bytes	$125.00
each 16k bytes	$600.00

APPLE-II prices with all memory options are:

Bytes RAM	Column A Price	Column B Price including 6½% sales tax California residents only
4k	$ 600.00	$ 639.00
8k	725.00	772.12
12k	850.00	905.25
16k	1,075.00	1,144.87
20k	1,200.00	1,278.00
24k	1,325.00	1,411.12
32k	1,675.00	1,783.87
36k	1,800.00	1,917.00
48k	2,275.00	2,422.87

Get on the List

Quantity	Memory	Price each*	Price × Quantity
1.	Apple-II(s) with ___ k RAM at $ ___	each. Total = $	
2. ___	Apple-II(s) with ___ k RAM at $ ___	each. Total = $	
3. ___	Apple-II(s) with ___ k RAM at $ ___	each. Total $	
	4. SUBTOTAL	**$**	
	5. 1/3 advance payment	**$**	
	6. BALANCE DUE (subtract item 5 from item 4)	**$**	

* **California residents** must include 6½% sales tax on retail sales and should use prices from column B in the price list (which already include 6½% sales tax).
Orders from all other states should use prices from column A.

Name _____

Street _____

City _____ **State** **Zip**

Date _____ **Amount enclosed $**

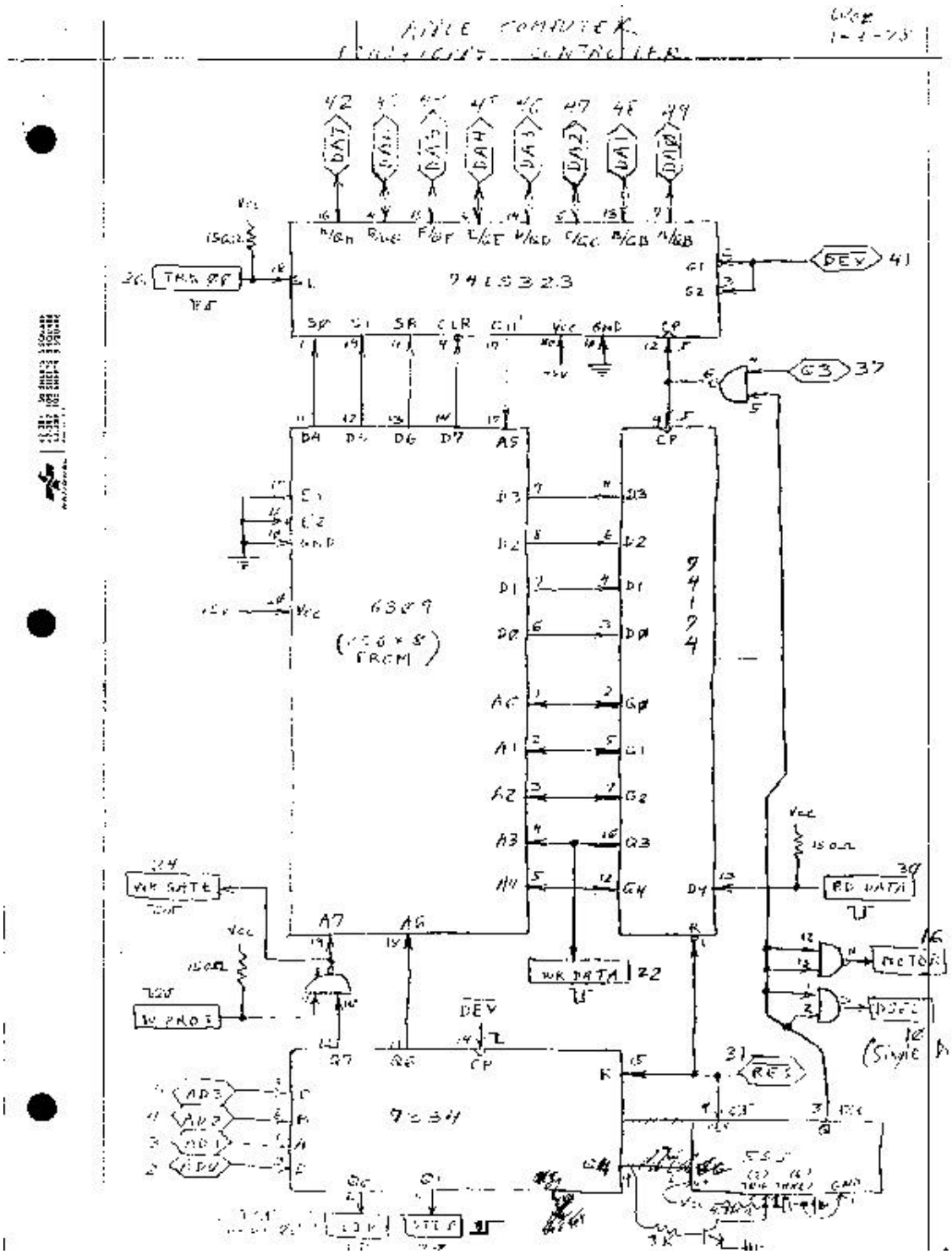
Signed _____

Two weeks later, I had left my safe, secure position with IBM to work at the three (now four) person company. Within days I had my very own Apple II work station. This computer was hand delivered to me by Steve Jobs. I learned that the Basic was go into Apple's next generation of computer, code named Apple Annie. Woz was very excited about this new machine. It was to have plug-in program ROM cartridges and lots of custom LSI.

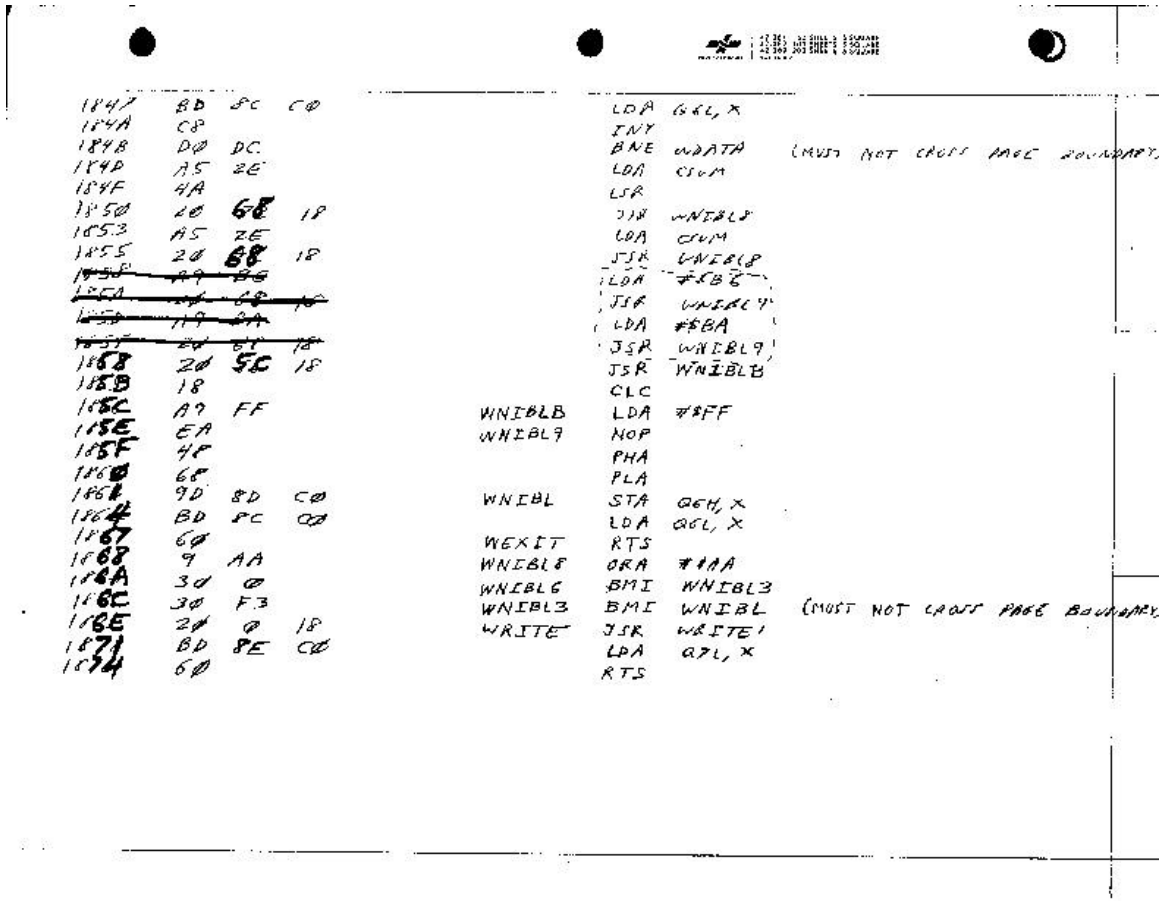
One problem that we had to solve was that of getting 6502 object code files into the Apple II from our development system The development system consisted of a national COPS microprocessor with a 6502 compiler created by Bob Shepardson. The input to the compiler was a deck of punched cards. The output was paper tape. How do you read paper tape into an Apple II? Woz had the answer. He built a card for the Apple II that would drive a paper tape reader. One day while Woz I were setting up the tape reader, I noticed that Woz seemed depressed. I asked what was wrong. He replied that he had developed a floppy disk drive for the Apple II. He was really proud of that, but Apple's management had given him an impossible schedule for the delivery of both the hardware and the disk operating system. I said I could do the disk operating system (DOS). Woz was delighted. After a quick consultation with Bob Shepardson and Steve Jobs, Woz and I started to work.

When Woz showed me the designs of the disk controller hardware and software driver. I was truly amazed. At that time, all disk drive controllers were big cards with dozens of large and small scale integrated circuits. The design Woz created required only seven small scale integrated circuits. What was even more amazing was that Woz's design had significantly better performance (data density, reliability, cost) than existing controllers. When Woz started this design, he did not look at how other people had done it. He thought about how it should be done. Using this process he created something remarkable. This became my real world example of what was to later be called "thinking outside the box." In my later life as an engineering manager, I have told the Woz Controller story to many engineers as way getting them thinking on a different path. Unfortunately, most engineers will never attain the level of Steve Wozniak's creativity.

[FIGURE] Woz's disk controller hardware:



[FIGURE] Woz's disk software driver:



```
184F  BD  8C  C0        LDA  G6L,X
184A  C8                INY
184B  D0  DC            BNE  WDATA     (MUST NOT CROSS PAGE BOUNDARY)
184D  A5  2E            LDA  CHKSM
184F  4A                LSR
1850  20  68  18        JSR  WNIBL8
1853  A5  2E            LDA  CHKSM
1855  20  68  18        JSR  WNIBL8
1858  A9  FE           LDA  #$FE
185A  20  5C  18        JSR  WNIBL9
185D  A9  FF            LDA  #$BA
185F  20  5C  18        JSR  WNIBL9
1862  18                CLC
1863  A9  FF      WNIBL8  LDA  #$FF
1865  EA          WNIBL9  NOP
1866  48                  PHA
1867  68                  PLA
1868  9D  8D  C0  WNIBL   STA  Q6H,X
186B  BD  8C  C0        LDA  Q6L,X
186E  60            WEXIT   RTS
186F  9  AA         WNIBL8  ORA  #$AA
1871  30  0          WNIBL6  BMI  WNIBL3
1873  30  F3         WNIBL3  BMI  WNIBL     (MUST NOT CROSS PAGE BOUNDARY)
1875  20  0  18      WRITE   JSR  WAITE
1878  BD  8E  C0          LDA  Q7L,X
187B  60                RTS
```

It took Bob Shepardson and Steve Jobs a couple of weeks to negotiate the details (cost, schedule, re-scheduling the Basic, etc.) and sign a contract. If you looked at this contract, you should be amazed. The cost to Apple was very small compared to the value Apple received. The schedule was very short considering the work to be done. The product specifications, deliverables, acceptance criteria, penalty/bonus clauses and legal mumbo jumbo that I have become used to in the years since were all missing. Those were the good old days!

[FIGURE] Contract:

Shepardson Microsystems, Inc.
20823 Stevens Creek Blvd.
Building C4-H
Cupertino, CA 95014
(408) 257-9900

April 10, 1978

Steve Jobs
APPLE COMPUTER INC.
10260 Bandley Drive
Cupertino, CA 95014

Dear Steve:

Per our discussions of the last 2 weeks we are developing the following components of an APPLE II operating system:

1. File manager
2. Basic interface for your integer BASIC and Applesoft BASIC.
3. Utilities for:
   a) backing up a disc
   b) disc recovery
   c) file copy

Not included are SYSGEN nor any other utilities. SYSGEN will be required as another component prior to your shipping DOS to customers. Apple to provide us with the disc driver software.

Price is $13,000. Payable as follows:

1. $5200. Now
2. $7800. Upon delivery.

In addition Apple is to give us two controllers with three drives.

Delivery will be May 15.

Sincerely yours,

Robert C. Shepardson
SHEPARDSON MICROSYSTEMS, INC.

RCS/ks

Shepardson

Now that I was no longer doing the Basic and because we had other work coming in, Bob needed to hire another programmer. I knew the perfect candidate. Kathleen O'Brien, my life partner, was a very good programmer - and we worked well together. A few weeks later, Kathleen was Shepardson Microsystems employee number 5.

During the time I was working on the DOS, big changes where happening at Apple. They moved from their small office space behind the Good Earth Restaurant in Cupertino to their new World Wide Headquarters on Bandly drive. (We used to joke about the World Wide part. Apple was a tiny start up that had just begun delivering its first production products. Shepardson Microsystems did a lot of projects for similar small start up companies that were going nowhere. Why should Apple be any different? At one point Steve Jobs offered to buy Shepardson Microsystems to form the nucleus for Apple's software development organization. Bob refused the deal. Steve was only willing pay for the Shepardson Microsystems with Apple stock. Bob might have been more interested, but Steve would not increase the offer beyond 10% of Apple's stock.)

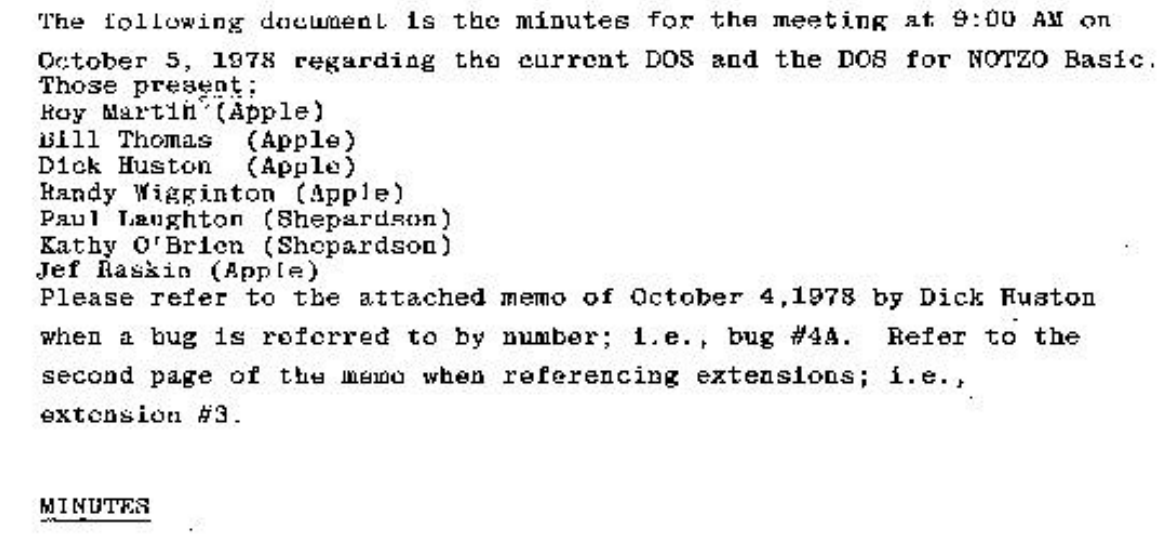
One of the big changes came when Apple hired Jeff Raskin to manage Apple's technical writing group. The task of writing the user manuals for the DOS and the new Basic fell on Jeff's shoulders. The task was particularly difficult since no form of specification existed for either product. Jeff had a nearly finished version of the DOS to work with. For the Basic, all he had was the syntax checker part of the code. Jeff's solution was to write the manual as the specification. This was all well and good, but Jeff had big ideas. As he was writing the manual, the specification for both products grew well beyond the scope of the original agreements. For DOS, this lead to several follow on, last minute contracts to cover Jeff's additions. Fortunately, the scope of the DOS changes where limited due to shipping deadlines. This was not the case with the Basic.

[CORECTION/DTC/22 DEC 2000: "Jeff Raskin" should be "Jef Raskin", one "f"]

Our little Basic grew and grew and grew. It would no longer fit in 48k of RAM. We were going to have to develop code segmentation and overlay methods. Jeff acknowledged the size of this monster by naming it NOTZO BASIC. We called it NutSo Basic.

The final chapter in our association with Apple came soon after a meeting with Apple in October, 1978. I have scanned Randy Wigginton's minutes of this meeting. The meeting.gif file is an small image of the introduction to this document. The meeting.txt file is an OCRed text file of the document. As you can see, the first part of meeting covers fixing some defects in the now shipping Apple DOS 3.0. The second part of the meeting covers discussion about the now bloated NOTZO Basic. I fixed the DOS defects by giving Apple a marked up listing. The Basic problem was fixed a short time later, when Apple canceled the Apple Annie project and the Basic contract. We at Shepardson did not mind. Atari wanted us to write a Basic for their new Atari 800 computer. That is another story.....

[FIGURE] Small image of the introduction to this [meeting] document.



The following document is the minutes for the meeting at 9:00 AM on October 5, 1978 regarding the current DOS and the DOS for NOTZO Basic.
Those present;
Roy Martin (Apple)
Bill Thomas (Apple)
Dick Huston (Apple)
Randy Wigginton (Apple)
Paul Laughton (Shepardson)
Kathy O'Brien (Shepardson)
Jef Raskin (Apple)
Please refer to the attached memo of October 4,1978 by Dick Huston when a bug is referred to by number; i.e., bug #4A. Refer to the second page of the memo when referencing extensions; i.e., extension #3.

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MINUTES

The meeting started at approximately 9:15.

Bill asked Paul when the bugs listed could be fixed. Paul responded that his work schedule was full for the next 6 months, but we would have to consult Bob to be sure.

Next was a bug-by-bug look through the list. Basically, everyone felt all those listed were actual bugs. There was some controversy as to whether bug #1 was or was not actually specified in the

original spec. Paul felt that bug #1 involved some major rework, and was a result of not having a written spec on the DOS.

Nobody who has looked into the DOS is sure why bug #2 exists, including Dick, Randy, and Paul. Paul was not sure how much work would be involved in fixing this bug.

Paul felt that bug #3 was trivial and he already knew how to fix it. Jef felt strongly that bug #3 was the most objectionable, and should be fixed first. Everyone present seemed to share this view.

Paul said that bugs #6 and #4B are easy to fix.
He also said that bug #4A could be fixed but he was not sure what would happen. Apparently the stack must be reset following an error condition, and he could modify the DOS so that the only time it reset the stack was when an error condition occurred.

As for bug #5, some controversy arose over whether it was a bug in Paul's DOS or in the Apple core routines, or~ even in the state machine itself.

At this time, the discussion moved to the extensions/enhancements listed on page 2.

Dick stated that most of the items on page 2 are trivial.

Paul questioned the reason for extension #2, and it was stated that the user should have the ability to both delete his DOS and to

Both Randy and Paul felt that extension #3 was trivial.

Everybody present exhibited a strong dislike of volume numbers, and Paul felt this change would also be very easy.

Paul was unaware of the need for extension #5. Randy said he could provide Paul with a subroutine to acoomplish the necessary task.

Extension #6 was felt to be nice to have but. not terribly important. Roy said that in addition to extension~#6A, we should print the percent usage of the diskette.

Extension #6B has already been done by Dick. There was some discussion about various methods of implenting extension #6C. Everybody felt this capability would be very useful.

Bill felt that a good policy in the DOS would be to not update the catalog until a file is closed. Paul said this would be a major revision.

Paul said the main problem with our DOS was that our Basics are in ROM

Paul has recieved questions directly regarding our DOS. Evidently he has been in computer stores, etc. when ~omeone was asking questions about the Apple DOS. He also was surprised that we were shipping documentation on the Read/Write a track and sector routine. He felt that documentation on interfacing to the file manager portion of the DOS was more useful. Randy pointed out that documentation does not

exist on the file manager.

Dick said that more documentation from Paul would be very helpful. Working without documentation is very difficult.

Bill brought up the point that '1adequate documentation" consisted of documentation to the point where one day1s work of programming could be reproduced in one day. He also said that Paul could tape comments, and we could type them up in the future.

Paul stated that our contract states that the listing is the extent of our documentation.

Bill brought up the point that Apple should only have one route for releasing a diskette into production. Jef agreed that his group should have the responsibility.

Paul said that he could spend either3 to 4 days documenting the DOS, or he could fix the bugs, and wanted to know which we wanted.

General opinion seemed to be that extensions #6E and #7 are not worth doing at present.

At this point, extension #8 was added to the list. After explaining what we anted to Paul, he said it was trivial.

Going back to page 1 to sum up, Dick again emphasized that bugs #2 and #3 were the most objectionable, and should be fixed first.

Paul still expressed some doubt as to what was causing bug #5, and bug #2 was a mystery.

Bill, Randy and Dick all felt obtaining a machine readable source of our DOS was the most pressing detail t6 be attended to. Paul said he will get the source to us as soon as possible.

Paul suggested the possibility~of giving us the source in a ma,chine readable form, and the changes in handwritten notes. This was acceptable to Bill, Dick, and Randy. Bill also wanted more complete documentation. Paul said we would have to negotiate a seperate contract for documentation.

At this point the discussion turned to the NOTZO Basic DOS.

Bill wanted to know if the DOS going into NOTZO was a change to the current DOS. Paul said there was very little change to the present DOS.

Jef suggested the possibility of getting rid of volume numbers entirely. Everyone present was very pleased with this, and Paul said it would simplify the NOTZO DOS. Jef then suggested getting rid of volume numbers in the present DOS. Most of those present felt this was inadvisable. Bill said we wanted to avoid major revisions to the present DOS, and felt we should maintain compatability.

Paul wanted to know whether the file manager portion of the DOS was proprietary, and if he could explain to users how to use it. Those from Apple felt that it was proprietary, at least until we knew how

to use it.

Jef said he wanted file and variable names to be of the same syntax, in order to save on syntax table size.

Kathy wanted to know if literals for file names must always have quotes around them. Apple agreed that this was a good idea.

Jef said he will come out with a new DOS specification, which would have semicolons after the filename and disk drive selection parameters. There was some discussion over whether we should allow the disk selection parameters to be in any order or be required in a specific order. Bill, Dick, Randy, and Roy felt it should not be required in a specific order.

Kathy brough up the fact that the NOTZO DOS that is spec'ed now is above and beyond the original contract, and we would have to negotiate a new contract for the DOS portion. Kathy said that Shep's has been asking Apple for a DOS spec for several months.

Noone from Apple was sure what the original spec was for NOTZO

Shep's people said that the original Basic contract included a 'Tsimple DOS". Both Kathy and Paul committed to a specification as to what a "simple DOS" would entail.

Kathy and Paul were upset that noone at Apple seemed to be the person to deal with for NOTZO Basic. Bill said from now on he will be the NOTZO spokesman. Bill said he would write a letter to Shep to cpnfirm this fact.

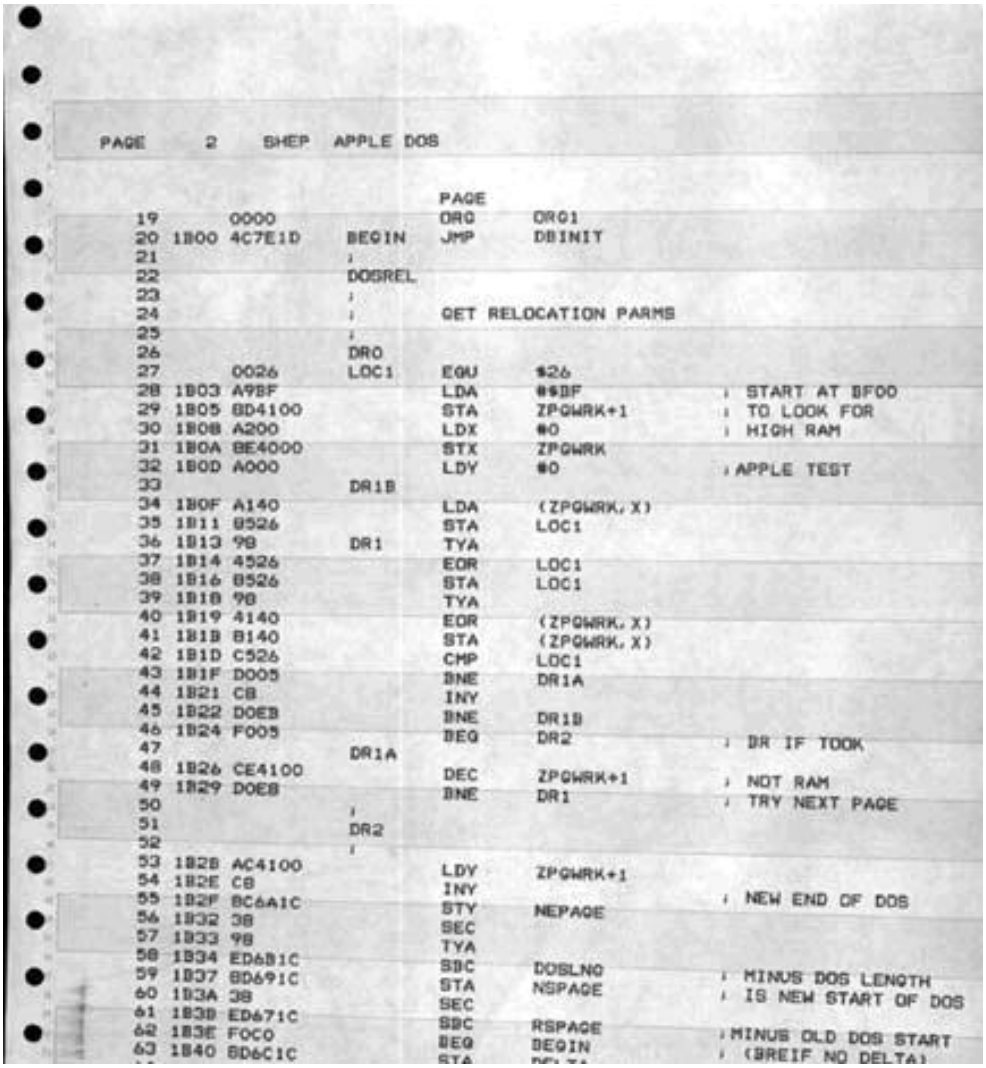
Kathy and Paul were very distressed over the whole NOTZO Basic dealing.

Randy recommended another meeting to settle the NOTZO Basic DOS question. Everyone felt this was acceptable.
update his DOS in case of a future revision.

Basic.

The meeting ended at 10:45 AM.

[FIGURE] I fixed the DOS defects by giving Apple a marked up listing:



```
PAGE    2    SHEP  APPLE DOS

                                PAGE
      19       0000             ORG     ORG1
      20 1B00 4C7E1D   BEGIN    JMP     DBINIT
      21                ;
      22                DOSREL
      23                ;
      24                ;       GET RELOCATION PARMS
      25                ;
      26                DRO
      27       0026     LOC1     EQU     $26
      28 1B03 A9BF               LDA     #$BF          ; START AT BF00
      29 1B05 8D4100             STA     ZPGWRK+1      ; TO LOOK FOR
      30 1B08 A200               LDX     #0            ; HIGH RAM
      31 1B0A 8E4000             STX     ZPGWRK
      32 1B0D A000               LDY     #0            ;APPLE TEST
      33                DR1B
      34 1B0F A140               LDA     (ZPGWRK,X)
      35 1B11 8526               STA     LOC1
      36 1B13 98       DR1       TYA
      37 1B14 4526               EOR     LOC1
      38 1B16 8526               STA     LOC1
      39 1B18 98                 TYA
      40 1B19 4140               EOR     (ZPGWRK,X)
      41 1B1B 8140               STA     (ZPGWRK,X)
      42 1B1D C526               CMP     LOC1
      43 1B1F D005               BNE     DR1A
      44 1B21 C8                 INY
      45 1B22 D0EB               BNE     DR1B
      46 1B24 F005               BEQ     DR2           ; BR IF TOOK
      47                DR1A
      48 1B26 CE4100             DEC     ZPGWRK+1      ; NOT RAM
      49 1B29 D0EB               BNE     DR1           ; TRY NEXT PAGE
      50                ;
      51                DR2
      52                ;
      53 1B2B AC4100             LDY     ZPGWRK+1
      54 1B2E C8                 INY
      55 1B2F 8C6A1C             STY     NEPAGE        ; NEW END OF DOS
      56 1B32 38                 SEC
      57 1B33 98                 TYA
      58 1B34 ED6B1C             SBC     DOSLNG        ; MINUS DOS LENGTH
      59 1B37 8D691C             STA     NSPAGE        ; IS NEW START OF DOS
      60 1B3A 38                 SEC
      61 1B3B ED671C             SBC     RSPAGE        ;MINUS OLD DOS START
      62 1B3E F0C0               BEQ     BEGIN         ; (BREIF NO DELTA)
      63 1B40 8D6C1C             STA
```

Why was the first release of Apple DOS called Apple DOS 3.1?

Every time I recompiled the code, I incremented a revision counter. The counter started at Rev 0.1. Whenever I got to (n).9, I would roll the counter over to (n+1).0 The first listing I gave Apple was Rev 2.8. They (I forget who) decided they could not call it DOS 2.8, so they changed it to DOS 3.0. Apple did the beta testing with this version (2.8 renamed 3.0). When Apple shipped the DOS for revenue, they incremented it to 3.1 to indicate that the code had changed from the beta version. As a final note, when I transferred the source code to Apple in October, 1978 the Rev number was up to 6.3.

For more on these topics, see Steve Weyrich's Early Apple History

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If you have any question or would like to make any comments, you can send me an Email at paul@laughton.com. Thank you for you interest.

Back to the Ada Byron Programming Center
