

# The Amateur Computerist

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## Return to Sanity With the Amateur and the Pro by Floyd Hoke-Miller

Realizing,  
Doubting not,  
We are standing  
At the Crossroads of  
confusion;  
Marking time,  
Directionless,  
Minus any concerted plan  
To correct  
Constitutional crises  
On the home front.  
Diplomatic danger  
Dominating  
All contact abroad;  
Genocide facing  
Homo Sapiens  
As a Species  
From terra firma.

Face aghast  
Tarnished by allegiance to  
Mars and Mammon  
Sabre rattling,  
Hate mongering  
Crying peace,  
Good will!  
Arming to the hilt  
Secretly.  
Voltaire ignored is  
Censorship,  
Frustratingly,  
Convertingly  
Hiding an  
Ugly head,  
Creating by so doing,  
Not democratic equity,  
But stark inequity

In hyperbole  
Let us say;  
Build the Big Brain  
Sans numbers,  
Doing the work for us all,  
All may then,  
Sit, Stand, Travel,  
Whatever ---  
We'll all be Bosses.

(Note: Voltaire was a proponent of free speech and freedom of the press. He said though: "I may disagree with what you say, I will dual to the death to defend your right to say it.")

## Letters from Readers

Thank you for your introductory edition of the *Amateur Computerist*. After I read it, it was distributed to my network instructor and then to my fellow students in IEEE. Everyone is excited. When I get a chance I will get a subscription.

I have some suggestions. As you know *Scientific American* publishes a column that has a lot to do with Mathematics. It's called "Metamathical Themas." It would be nice if someone in the society could review the column and see how it could apply to the computer. Then if someone comes up with something that's really ground breaking the society will gain more ground with the general public.

Another idea is to have someone collect all the programs he or she can in BASIC, Fortran, et al, and send them to you or someone else to collate and get an advisory panel to judge which is the best. That would

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lead up to a giant library getting started where disks are available for a small fee to anyone who wants them. If you could get some of the colleges like MIT, CAL TECH, and others in on this after awhile the FIRST AMATEUR COMPUTERIST CONGRESS can convene. Of course membership just doesn't have to be for Americans and Canadians - extend it world wide.

There's one more area I would like to see developed and elaborated upon and that is "Courseware" software that teachers use for their courses. That should have a separate column.

The art part should include making pictures with computers and doing the things that the comic book artists do. Awards and Scholarships can be handed out. Finally, we should have branches, regions or whatnot to help you do this. And a logo is needed if you don't have one already.

Thank you  
GARY CHESTNUT

I was pleased to see your letter in *Radio-Electronics* announcing the start up of the *Amateur Computerist* newsletter, and would like to be added to the mailing list to receive it. If there is a subscription charge, or if contributions to defray expenses are acceptable, please let me know and I'll send a check. There have been newsletters devoted to particular systems, but I feel there is a need for broader coverage.

A bit about myself: I'm a semi-retired chemist with an interest in building and using computers which goes back quite a way, though with little accomplished. Unfortunately, I was unaware at the time of Stephen Gray and the "Amateur Computer Society". However, some 25 years ago I did acquire one of the original Heath analog computers (with 15 wildly drifting op-amps!) and still have it.

About ten years ago I started to construct Hal Chamberlin's IMP-16 system, which he described in the old *Computer Hobbyist*. I never did get it finished due to the demise of the *Computer Hobbyist*, and subsequently of National's *Bit Buck* which reprinted Chamberlin articles, which Hal apparently never completed. I

still have the boards and chips for it, but there's no point in working with a system which is now obsolete, though very powerful for its day.

Next on my list of unfinished projects was a Z-80 system, based on the surplus Xerox board. I have this completed and may even get around to firing it up one day.

My present system is a Slicer 80186, built from their kits. This comprises the CPU and 1-meg expansion boards, with Heath H-29 terminal, two 360-K floppies and a NEC P6 printer, running MS-DOS 2.1. I'll have to add their PC board if I'm going to run much commercial software.

My present interest is in working with full 32-bit systems based on the National 32032 or the Motorola 68020. As you may know, Rick Rodman (1923 Anderson Road, Falls Church, VA 22043) publishes an informative newsletter devoted to the former. The low-priced 32016 and 32032 kits available through National's distributors, facilitate designing around these chips. I got a 32032 kit thru Hamilton/Avnet about 18 months ago for \$70. An upgraded version is now available. This is quite good as it provides schematics from which one can wire-wrap a board, and TDS ("tiny development system") ROMs, in addition to a 6-MHz chip set.

Hamilton/Avnet also has a 68020 kit (pricey at \$329.50!), but it has 16.7-MHz parts (68020 CPU, 68851 MMU, 68881 FPC), 4x32K of 35-nsec static memory, and two A/D converters (seems to be oriented toward controller systems). Documentation comprises manuals for the 68xxx's and a loose-leaf binder of reprints (mostly quality advertising). There are no schematics or other guides for construction. If you buy the kit, Hamilton/Avnet will provide separately a monitor in ROM for the price of a 27256 (or you can supply the ROM and they'll program it free.) But they tell me no documentation is provided for the monitor.

Perhaps some previously published constructional articles on 68000 systems could provide information applicable to designing a 68020 board. Ed Scott's uncompleted series on

68000 design, which appeared in the late lamented *Computersmyth* and Peter Stark's series in *Radio-Electronics* should be helpful. Anyway, I'd be interested in seeing material in the newsletter, or hearing from anyone working with, or contemplating, a 68020 system. (The latter is the present extent of my involvement.)

Norman F. Stanley  
Rockland, Maine

It's a wonder what you can find when you're not looking. First, I found some information on supercomputers and parallel processing in some engineering magazines. A lot of it I understand, but some of it is still Greek to me. Also I found a technical reference manual for my CoCo III. There were actually some interesting things in there that, for some reason, Radio Shack chose to hide. But I haven't had much time to work on my computer for a while because of school and work, so it'll be a while before I can do any computer work.

I mentioned in my last letter that some of my interests are scientific in nature, so I've been trying to figure how the higher-number functions work in machine language. But I haven't figured out much beyond the basic functions (addition, subtraction, multiplication and division). When I find the answers, I would like to pass on what I find.

Has anyone else written in with an interest in building their own computer? I have a very ambitious long range goal in building my own system and would like to hear from others.

Another amateur computerist,  
Steve Bouton  
Cairo, GA

Please send me the first three issues of your *Amateur Computerist* magazine. I have written many articles for *Micro* and *Peek* magazines before they folded up. I have also published articles in the Australian Computer newsletter *KAOS*. Last week I sent in an article to *Computer Shopper*. So I am no stranger to authorship.

Since I purchased this IBM clone, my home brewing activities seem to have ceased. The new computer already has all the features I was trying to construct.

I am also interested in amateur radio, and can communicate with other computers with a radio modem. This is known as "Packet Radio".

Earl Morris  
Midland, MI

After noticing a letter from your *Amateur Computerist* newsletter in the September *Radio-Electronics* I thought that your group might be able to help me. I am having trouble getting any help concerning a MC68000 computer that I unfortunately purchased on *Radio-Electronics* recommendation from Computer Express from Corvallis, OR. That motherboard, unpopulated plus the manual cost me \$500. After spending over \$500 for required parts and fighting incorrectly labeled and incorrectly identified parts, most of what I need to complete the system I have found. Some of the parts I need I have not managed to find anyplace. I have not received any response from Computer Express or *Radio-Electronics* concerning these problems. Listed are some of the problems I still have not worked out. I am unable to find the below parts anywhere.

(74LS172, 74ALS253, 74ALS648, 74ALS74, 2149-2(35-45ns) NEC, 9229-B, MC68000 or MC68010 {8 MHZ pin grid socket (no standoff)})

The motherboard is too large to fit into a full size AT case. The suggested 200 watt power supply is unavailable thru any manufacturer or distributor so I had to use a AT 200 watt power supply.

As I can not get any response from Computer Express, 1425 NW Monroe ST. Corvallis, OR. 97330, (503)757-2984 or from *Radio-Electronics*, I am unable to purchase ram board, speech-clock board, V24 board or any software once I do manage to get the required parts.

Needless to say, I am totally disgusted with *Radio-Electronics* and Computer Express. I purchased the motherboard after I read the first article in *Radio-Electronics* about

the MC68000 more than a year ago. After one article which mentioned there would be additional articles on the computer and *Radio-Electronics* would be associated with the MC68000, I laid out the money. Immediately after the first article *Radio-Electronics* stopped any reference to the MC68000 and later started an entire series of articles on the PT68K, an entirely different system. Neither *Radio-Electronics* nor *Computer Express* has responded to any of my letters and I gave up hope until I read of your newsletter. If you know of anyone who has managed to get this system operational or even find required parts please let me know. I would appreciate any help in this area and am interested in receiving your newsletter.

Respectfully

S. Sgt. Charley D. Campbell

(Editor's Note: We do not know why Sgt. Campbell had the trouble he did. We sometime have trouble with the U.S. mail. We suggest he write to the author of the article in *Radio-Electronics* with the problem he has had. We are publishing the letter here in hopes that some reader may be able to help the sergeant find the solution to the trouble he is having.)

### PROBLEM CORNER

I would like to know if there is a way to quit a game without rebooting. There is a game that I would like to have someone write a batch file for that will allow you to stop or break out of the game at any point.

Norman

### TRY THIS for IBM

```

10 KEY OFF:CLS
20 INPUT "Input a number from 20 to
150 :",A
30 PI=4*ATN(1)
40 FOR R=1 TO 250
50 IF R<=24 THEN Y=R:GOTO 70
60 Y=24
70 X=40+35*SIN(2*PI*R/A)
80 LOCATE Y,X :PRINT""
90 NEXT
100 CLS
110 GOTO 20

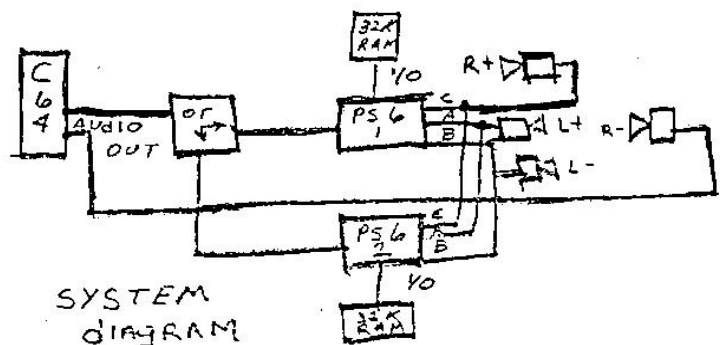
```

Boy was I glad when I saw your article in *Radio-Electronics* magazine. I have been currently pulling my hair out, trying to design a computerized quadraphonic sound system based on an INS8039 11Mhz microprocessor. The sound chips are two AY-3-8910 programmable sound generators with 64 K of RAM. I was also trying to use my Commodore 64 computer as the main controller for the system. But, I think I've gone over my ability in trying to construct this device. And do I need the help.

Anyway, is it possible to get more information on the newsletter? For instance, how do you present a problem like this one to your readers.

I would be most grateful for help.

Thank you very much,  
John Gritzmacher Jr.



### Response to October Editorial

(Editor's Note: The following response was received from Jud Kempson, an assistant editor of *Agenda*. A version of the editorial "Upcoming Elections and Computers" by Ronda Hauben was printed in the *Agenda* newspaper in their Nov. 1988 issue.)

I have problems with the economic theory underlying the article. She talks a lot about economic "incentive" to invest in new technologies, yet companies are withdrawing from their investment. If free market forces are pushing companies to invest, then why do they fall back on labor to increase their profits? Perhaps she needs to take it further and comment on the shortsightedness of relying on free market forces and profits for productive longevity. In the short run, labor-intensive opera-

tions will manifest themselves in immediate profits while investment of capital in technology lend itself to long term economic vitality and health at the cost of profits. Also, I think she needs to explore the role of unions more, especially the tension between union laborer and union official. How, for example, did the Flint workers prevail in their contract negotiations in 1948 when UAW International Officials opposed them? Once again, how *exactly* do union contracts provide companies with "incentive" to invest in technology. Why the *personal* computer and the shop floor? How exactly will they tie together? What is her vision of how a technologically state-of-the-art factory would operate? How do workers fit in? Would they all be programmers? What are the incentives for companies to re-train line workers? What about those workers who are not technologically inclined?

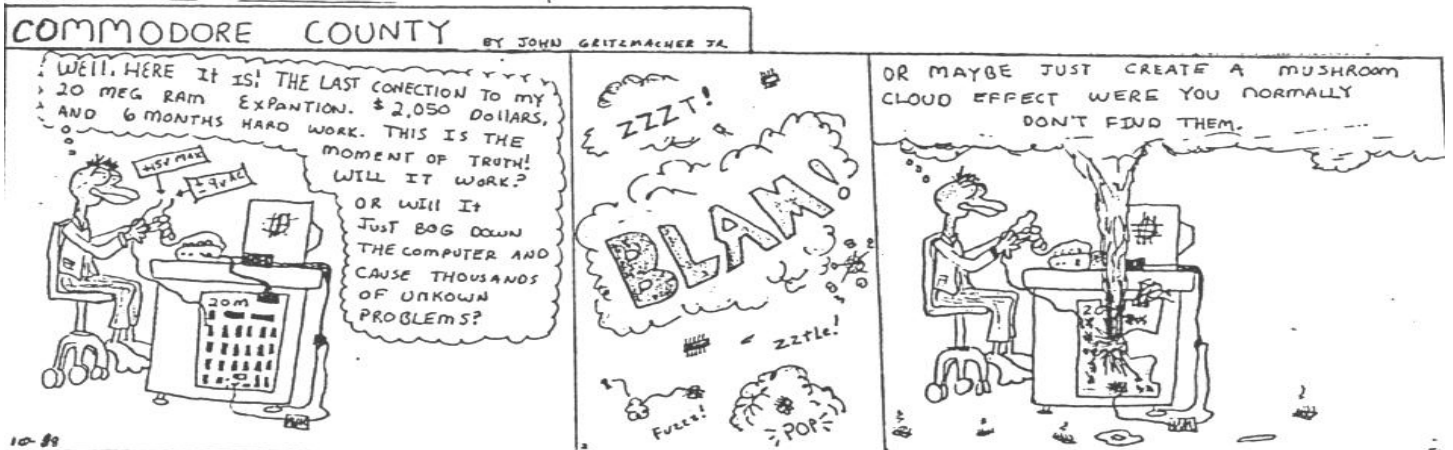
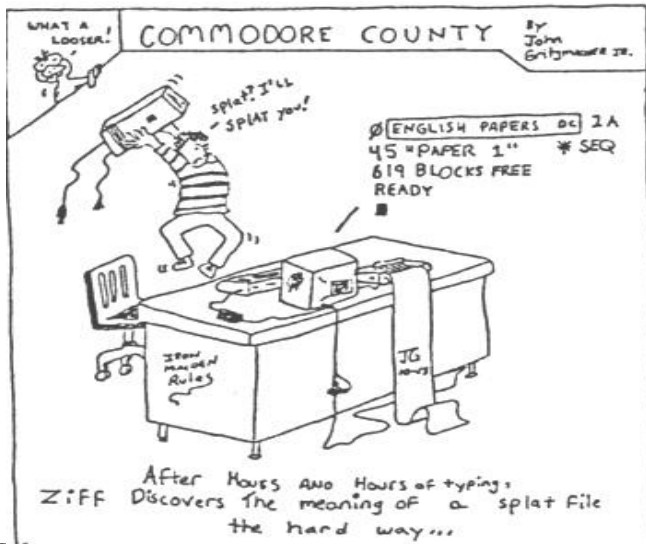
(Jud Kempson is Assistant Editor of AGENDA, 202 E. Washington #512, Ann Arbor, MI 48104.)

### WELCOME TO COMMODORE COUNTY USA

It was even better hearing back from you that you received my letter. When I read your letter, I was most excited to hear that you were accepting articles, cartoons, and other things. I know that my artwork is not the best and you probably have standards, but I have come up with a comic strip of my own. It's called "Commodore County". In the first few strips I manage to introduce a few of my characters and relay some common problems of Commodore users, and the experimenter in general.

Starting off we have Ziff, a computer hacker that cannot understand why the computer cannot find his files. And then we have my favorite, Conrad "Chip" Fernow, a duck with an uncanny sense of experimentation, and Sandra Mcgee, Ziff's little sister, who commonly is found chewing on floppies and carrying around Ziff's power supply by its cord. I will be introducing other characters in time, but for now that's all I've come up with. I have several more I've been toying with but haven't put them to ink yet. I hope my drawings are up to your standards. I am not saying that they are good by any means, but I like to try anything that's possible once. So thanks for your consideration, and here is my five bucks. Sign me up for the year and I will have a question or two, or three, or four, coming up in future letters. So thanks again and see you around in Commodore County!

From the Head Hacker in Commodore County USA. John Gritzmacher Jr.



## COMPUTER HACKING, A CRIME?

By Michael Hauben

(Editor's Note: On Nov. 9, 1988, the *Detroit News* published an editorial "Hate Not the Hacker." They were commenting on the press coverage about people like Robert Tappon Morris, the 23-year old Cornell University graduate student who found an important flaw in a U.S. government computer system. The *Detroit News* joined the press chorus demanding a criminal penalty for Robert Morris, asking that he be "prosecuted to the fullest extent of the law." And they recommended "penalties for computer tampering can be made more severe."

Surprisingly, though, the *Detroit News* editorial ends by saying "Most hackers stay within the law and many computer system operators can help their own cause by improving security. It is in our own interest, however, to see to it that minds like this are encouraged in their pursuit of new knowledge."

But Robert Morris did no harm and in fact he performed a service. He showed some of the weaknesses of a government computer system so they could be corrected. He should be rewarded, not condemned or subjected to criminal prosecution. But there has been a long series of efforts by the U.S. government to try to enact criminal penalties against computer enthusiasts and to label all computer hackers as criminals. This effort needs to be countered by computer lovers. It was good to see Steve Wozniak, who created the Apple computer, defend computer hackers on TV Channel 7's "Nightline" program. He refused to allow them to be confused with white collar criminals. The following article shows that this effort to label computer hackers as criminals is not new.)

Is computer hacking a crime? That is what all of the magazines seem to say. On the other hand, hackers say that hacking is a challenge and it's interesting. First we need to know some definitions. BBS is an acronym for Bulletin Board System. A BBS is generally what it says it is, a place for posting messages, although the

information is transmitted electronically over the phone lines. A modem is a device that sends computer data over the phone lines to another modem hooked up to another computer.

The word "Hacker" can have several meanings. In a dictionary one would find "cab driver" and in the book *Out of the Inner Circle* by Bill Landreth ("The Cracker") you would find for the 1980's the definition of the word "hacker: A person who often attempts to gain unauthorized access to large systems by using his personal computer equipment." But I think the word "hacker" has a wider range of meanings, going from Bill Landreth's definition to my definition, which is to find out about undocumented features of your personal computer.

An article in *Newsweek* magazine shows how hackers were arrested for no reason. The article said that police in suburban New Jersey seized 7 teenagers' computers, modems & other equipment. The prosecutor charged the teenagers with the "usual" (conspiring to use stolen credit card numbers and to make illegal long-distance phone calls and illegal purchases.) Plus, they were charged with "changing the positions of satellites up in the blue heavens," and with obtaining secret phone numbers of top Pentagon brass. On a local computer bulletin board "they had also exchanged information," the prosecutor said, on how to build letter bombs and they had "threatened this nation's defense" by publishing a secret phone number for computer access to the defense contractor TRW which included information on military tank parts. The story became a lead news item, but was it a real-life security risk? "Our satellites have not been moved," insisted an AT&T communications spokesman. "It's close to impossible," he added. The Pentagon also said that there was no security breach there. TRW, who does not make any tank or tank parts said there were no security breaches either. "Frankly, [the police] don't know what they've got," said a TRW spokeswoman. The assistant prosecutor said, "We got numbers that say they can do

things, but we don't know if they did them."

I leave it to you to draw your own conclusion but I think it is all a big scare. Take, for example, this quote, from "Beware: Hackers at play" in Newsweek: "It's time to put the fear of God into people," said by a Pentagon deputy.

Bibliography

Out of the Inner Circle, by Bill Landreth, (Bellevue, WA., 1985)

"Was It Really War Games" by William D. Marbach, Newsweek, July 29, 1985, P. 23

"Beware: Hackers at Play " by William D. Marbach, Newsweek, September 5, 1983, P. 42-48

**IBM KEY ASSIGNMENTS  
USING The "PROMPT" COMMAND**

A. Introduction

Dos can be used to assign a string or command to any key. After which, a press of that key will send the string or command to the CPU. This process requires ANSI.SYS to be in the CONFIG.SYS file, and that these files be in the root directory of your system.

B. Assignment of Keys

An assignment file can be made with EDLIN, an ASCII word processor or editor, or "copy con". This article is based on the use of an ASCII editor. This is noted because of the variation in the handling of the "ESC" character (ASCII 27). Various editors use different characters to represent ASCII 27 (ESC); for example, \$e[, ^[, ^[[, etc.

1. Pre-assigned F-keys

For this discussion Keys F1 thru F6 are considered to be under the control of DOS for use in editing and EDLIN.

2. Other keys than F-keys 1 to 6

Many other keys can be made to do what you wish. This presentation will use key F7 for a typical example.

3. Meta-string

Meta-string is the name for an assembly of characters that work in harmony for a particular purpose. The DOS command PROMPT uses "\$e" for escape (ASCII 27), and when combined with certain ANSI code (eg. "[" can

be used to make new assignments "ala ANSI" to the buttons on the keyboard.

C. Extended Character Codes

To assign a string or value to a key, it is necessary to know the extended code for that key. There are two groups of code for keys: the standard ASCII code keys (letters, numbers, and some controls); and the other keys that are specific to IBM and its compatibles. The latter are the F-keys separately and in combination with ALT, SHIFT, and CTRL, and some other keys and/or combinations. A partial table of some "Extended Character Codes" for F-keys in combination is shown below:

KEY	Normal	Shift	Ctrl	Alt
F1	59	84	94	104
F2	60	85	95	105
F3	61	86	96	106
F4	62	87	97	107
F5	63	88	98	108
F6	64	89	99	109
F7	65	90	100	110
F8	66	91	101	111
F9	67	92	102	112
F10	68	93	103	113

For key definition, the above numeric's are preceded by a zero (0) and an ";" to complete the code; e.g.- code for F7 is "0;65", and for ALT+F7 is "0;110".

D. ANSI assignments

1. ANSI control sequences used in key assignment are :

- (a) ESC [ Pn ; "string" ;Pnp
- (b) ESC [ Pn;Pnp (where the change is from the 1st Pn to the 2nd Pn)

where "\$e" is used for ESC (ASCII 27), "[" is an ANSI control code, "Pn" are numeric parameters (specified with ASCII digits), "string" can be a file name, a command, a string, or a character, and "p" is an ANSI control code. Spaces are used in this text for readability - **DO NOT** space code when you write.

2. When combined with Prompt requirements, the ANSI control sequence shown as (a) above becomes:

- PROMPT \$e[ Pn ; "string" ; Pnp
- a) "PROMPT \$e[" begins the reassignment.
- b) The first "Pn" in (a) is to be

an extended character code referencing the key desired to be changed. For example, F7 has an extended character code value of 65. But since it is an extended character, its value will be written as "0;65". If it were a standard ASCII character, its ASCII value alone would be used. So the command becomes:

```
PROMPT $e[0;65;"string";Pnp
```

c) The second ";" separates the F7 key (with extended character code number of 0;65) from the "string".

d) As an example DIR /W A: will be the desired output when the F7 key will be pushed, so that will be the "string" in the new key setup.

```
PROMPT $e[0;65;"DIR /W A:";Pnp
```

NOTE: The string - DIR /W A: - is enclosed in quotes. This is necessary !!!!

e) The third ";" separates all that precedes the final numeric parameter, if any, and the control letter "p". Since the new assignment will be self executing, a carriage return (ASCII 13 - not an extended character, so no "0;") is necessary. If it were not to be self executing the number 13 would be omitted.

The completed line now reads:

```
PROMPT $e[0;65;"DIR /W A:";13p
```

NOTE: The final "p" is required by ANSI for the revised key to do its thing.

E. Removal of Assignment of Keys

To remove an assignment from a key, simply reverse the method described above to produce a prompt as follows;

```
PROMPT $e[0;65;"";13p - or -
```

```
PROMPT $e[0;65;0;65p
```

NOTE: In the above case the quotes enclose a null (or nothing) !!! F7 normally has nothing assigned to it by System. The latter form is preferred.

F. Restoring the system prompt

As with anything, nothing comes free. With all these "prompt" changes, what will happen to the system's original prompt? Well, it must be re-instated. So, another prompt command must be added. A simple DOS command would be:

```
PROMPT $p$g
```

G. A KEYSON.BAT File

F7 to Execute DIR/W in the A Drive:

```
KEYSON.BAT
```

```
ECHO ON
```

```
PROMPT $e[0;65;"DIR/W A:";13p
```

```
PROMPT $p$g
```

H. A KEYSOFF.BAT File

To Re-Instate the Original Condition:

```
KEYSOFF.BAT
```

```
ECHO ON
```

```
PROMPT $e[0;65;"";13p -or-
```

```
PROMPT $e[0;65;0;65p
```

```
PROMPT $p$g
```

NOTE: The above batch files will not work with "echo off". More than one key can be re-defined in a file. Limit commands to two to a line.

I. Limitations

Some programs will override the re-assignments you may make. BEWARE !! The buffer that holds this information is about 190 bytes. This may allow maybe 20 keys to be redefined. If the buffer is overloaded there is no warning and the system will crash.

J. More Extended Character Codes

KEY(S)	CODE	KEY(s)	CODE
NULL	3	Shift-Tab	15
ALT+Q,W,E,R	16-19	ALT+T,Y,U,I	20-23
ALT+O,P	24-25	ALT+A,S,D,F	30-33
ALT+G,H,J,K	34-37	ALT+L	38
ALT+Z,X,C,V	44-47	ALT+B,N,M	48-50
HOME	71	Cursor up	72
Page up	73	Cursor left	74
Cursor right	77	End	79
Cursor down	80	Page down	81
Ins	82	Del	83
CTRL-PRTSCR	114	CTRL+Curs.left	
CTRL+Curs.right		(prev.word)	115
(next work)	116	CTRL+End	117
CTRL+Page dn	118	CTRL+Home	119
ALT+1,2,3	120-122	ALT+4,5,6	123-125
ALT+7,8,9	126-128	ALT+0,-,=	129-131
CTRL+Page up	132		

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## HISTORY of COMPUTERS THE COMPUTER AS A LOGIC MACHINE

By Ronda Hauben

### INTRODUCTION

This article grew out of the experience the writer had over a period of 2-1/2 years teaching computer programming in the UAW-Ford Employee Development Center at the Dearborn Engine Plant of the Ford Rouge Complex. People taking the classes were interested in the computer as a machine and how it functioned. Consequently, they were interested in learning how to program. The computer is in some way like other electronic machines, but here it's as if the wiring is inside instead of outside. And by typing in a program you change the content of the addresses instead of physically resetting the wiring. By learning to do some simple programming you can see what the computer can do and how.

But, the computer programming classes were ended by Ford and the UAW, despite the fact that UAW members protested by writing letters, signing petitions, etc. The *Amateur Computerist* newsletter grew out of the realization that we could not rely on companies to support the dissemination of computer knowledge.

To support Ford's opposition to the spreading of computer programming knowledge, there is a stream of thought in the field of education that maintains that it is a waste for most people to learn to program a computer. According to this school of thought, using a computer only requires that a person get used to the keyboard and learn how to run software.

To get a better perspective on this debate, it proved helpful to review the history of computers. That history sheds real light on the controversy and so the *Amateur Computerist* has agreed to publish this article in serial form.

### PART I

The history is accompanied by a program as an illustration. Readers who have computers are encouraged to type in the program and to run the section of the program listed. (\*Note: The IBM Compatible version of the program accompanies the article. If any readers have suggestions on how to improve the program, please send us your comments.)

```
10 PRINT "HISTORY OF THE
COMPUTER"
30 PRINT
40 PRINT "THE COMPUTER AS A
LOGIC MACHINE"
50 GOSUB 5000
80 PRINT "THE NEED FOR A
MECHANICAL CALCULATOR"
90 PRINT
100 PRINT "1000 + 9999 = ";
1000+9999
110 PRINT "10 * 1000 = ";
10*1000
120 PRINT "333222 - 29999 = ";
333222-29999
130 PRINT "5321/3.1 = "; 5321/3.1
135 GOSUB 5000
4999 END
5000 REM subroutine to stop
program
5005 Locate 20,1
5010 LINE INPUT "Press Return to
Go On"; A$
5030 CLS
5040 RETURN
```

The modern day computer owes its origin to hundreds of years of effort by many people to create a machine to do mathematical calculations. From at least the 1600's on, scientists and mathematicians have been trying to find a mechanical means to alleviate some of the drudgery of calculations.

```
140 PRINT "SCHICKARD, BORN 1592"
150 PRINT "CALCULATING CLOCK 1623"
155 GOSUB 5000
```

By 1623, the first known mechanical calculator had been conceived and put together by William Schickard, born in Germany in 1592. Schickard was a friend of Johannes Kepler, the mathematician and astronomer. Schickard came to see the need for a mechanical calculator and on Sept. 20, 1623 he wrote Kepler:

"What you have done in a logistical way (i.e. by calculation) I have tried to do by way of mechanics. I have constructed a machine consisting of eleven complete and six incomplete... sprocket wheels which can calculate. You would burst out laughing if you were present to see how it carries by itself from one column of tens to the next or borrows from them during subtraction." (quoted in *Bit by Bit* by Stan Augarten, N.Y., 1984, p 18)

Schickard called his machine The Calculating Clock. But it fell victim of a fire and was lost until the 20th century when a working model was put together from drawings preserved with Kepler's papers.

```
160 PRINT "PASCAL BORN 1623"  
170 PRINT "PASCALINE 1642"  
175 GOSUB 5000
```

For a long time knowledge of the Calculating clock was lost to mankind and instead the Pascaline invented by Blaise Pascal (b 1623) was credited with being the first working mechanical calculator. Pascal's father was reported to have been a tax collector who was burdened by mounds of arithmetic calculations. The young Pascal wanted to find some way to help his father, some way to relieve the tedium of numerical computation. In 1642, when Pascal was 19 years old he created a mechanical calculator he named the Pascaline.

The machine worked well only with addition. But the machine created a sensation among the elite of Rouen, Pascal's hometown. Visitors came trooping through the Pascal home to see the wondrous machine. However, the Pascaline cost the equivalent of a wealthy Frenchmen's income for a year. And so not many were sold or actually put into use. Yet the Pascaline did a lot to publicize the desirability of finding a machine which could do numerical calculations.

```
180 PRINT "LIEBNIZ BORN 1646"  
190 PRINT "STEPPED RECKONER  
1672-74"  
195 PRINT  
200 PRINT "THE ESSAY TITLED"
```

```
210 PRINT "DE ARTE COMBINATORICA  
1666"  
215 GOSUB 5000
```

The third great mechanical calculator of the 17th century was invented by Gottfried Wilhelm von Leibniz (1646-1716). It was called the Stepped Reckoner. Most of the mechanical calculators built in the next 150 years were modeled on this invention of Leibniz. Leibniz understood the great need of astronomers for such a machine. He is quoted as saying, "Also the astronomers surely will not have to continue to exercise the patience which is required for computation. It is this that deters them from computing or correcting tables... from working on hypotheses and from discussions of observations with each other. For it is unworthy of excellent men to lose sleep like slaves in the labor of calculation which could safely be relegated to anyone else if machines were used." (quoted in *The Computer from Pascal to von Neumann*, Herman Goldstine, New Jersey, 1972, p 8)

In 1666 Leibniz made another contribution to the history of computers. He wrote an essay on probability called "De Arte Combinatorica". Later this essay would prove important for others like George Boole who helped set the logical foundation for the modern computer.

```
220 PRINT "THE INDUSTRIAL  
REVOLUTION"  
230 PRINT "BEGINS WITH MACHINES"  
235 PRINT  
240 PRINT "SPINNING MACHINE 1735"  
250 PRINT "FLYING SHUTTLE 1770"  
260 PRINT "SPINNING JENNY 1770"  
270 PRINT "WATER FRAME 1771"  
280 PRINT "POWER LOOM 1785"  
285 GOSUB 5000
```

By the early 1800's, the industrial revolution was in full swing in England. The development of a machine that could do the work of a man, like the Spinning Machine invented by John Wyalt in 1735, was the impetus setting off the technological explosion. Machine after machine was invented that meant the old handicraft ways

were being challenged in sphere upon sphere. Kay's Flying Shuttle and Hargreaves' Spinning Jenny, in 1770. Arkwright's Water Frame, in 1771, Cartwright's Power Loom in 1785, etc.

```
300 PRINT "CHARLES BABBAGE BORN
1791"
310 PRINT "DIFFERENCE ENGINE 1823"
315 GOSUB 5000
```

By the early 1800's Charles Babbage (1791-1871) was studying at Cambridge University. He and a friend had undertaken the obligation of calculating some of the numerical tables needed by astronomers.

```
320 PRINT "THE NEED FOR TABLES"
325 PRINT
330 PRINT "NUMBER", "SQUARED",
"CUBED"
340 FOR T = 1 TO 10
350 PRINT T, T*T, T*T*T
360 NEXT T
365 GOSUB 5000
```

Scientists needed various arithmetic tables, but the numerical calculations required were often very tedious, and filled with errors. There was a real need for some kind of mechanical means to simplify and make more accurate the calculation of these arithmetic tables. (If you look at the program in lines 320-360 it shows how the computer has indeed simplified the ability to calculate such tables.) Babbage tells the following story in his autobiography *Passages*. He writes:

"The earliest idea that I can trace in my own mind of calculating arithmetic tables by machinery arose in this manner:

One evening I was sitting in the rooms of the Analytical Society, my head leaning forward on the table in a kind of dreamy mood, with a table of logarithms lying open before me. Another member, coming into the room, and seeing me half asleep called out 'Well Babbage, what are you dreaming about?' to which I replied, 'I am thinking that all these tables (pointing to the logarithms) might be calculated by machinery'." (IBID., p 11)

Babbage realized the need for a mechanical means of doing these calculations, so he set to work designing a model of such a machine. His model used falling weights raised by a steam engine. He had a working model by 1822. It was a six digit calculator made of toothed wheels run by a hand crank. It was only a sample of what he wanted to do, but it proved his idea was possible. He called his model the Difference Engine.

```
400 PRINT "POLYNOMIALS"
410 PRINT "THE METHOD OF
DIFFERENCES"
415 PRINT: PRINT
420 PRINT "TABLE FOR X^2 + X + 41"
430 DIM B(20), C(20), D(20), E(20)
440 PRINT "X", "X*X+X+41"; TAB(25)
"DIFF"; TAB(30)"DIFF"; TAB(35)
"DIFF"
450 FOR I= 1 TO 15
460 PRINT I,: B(I)=I*I+I+41: PRINT
B(I);
470 IF I > 1 THEN C(I) = B(I) -
B(I-1): PRINT TAB(25)C(I);: IF
I = 2 THEN PRINT
480 IF I > 2 THEN D(I) = C(I) -
C(I-1): IF I > 2 THEN PRINT
TAB(30) D(I);: IF I = 3 THEN
PRINT
490 IF I > 3 THEN E(I) = D(I) -
D(I-1): PRINT TAB(35); E(I)
495 PRINT
500 NEXT I
505 GOSUB 5000
```

Babbage based his model on a property of polynomials to end up with the same differences, after a number of steps, depending on the degree of the polynomial. That's why his machine was called the Difference Engine. One of the polynomials Babbage was particularly interested in was the equation  $x^2 + x + 41$  because that would give prime numbers for the first 40 numbers. He used this equation to set up his Difference Engine.

The Difference Engine had been a specialized machine. It had only one function it could carry out -- that is calculating a table for up to a 6 degree polynomial, but the machine was not any faster than a person would be doing the same calculations.

However, a machine had been created to do some work not before mechanically possible. Babbage realized that a full scale machine, as opposed to the model he had created, would be expensive, so he applied to the British government for funding. His project to build a full fledged machine, which he called the Difference Engine, began in the fall of 1823. He ran into lots of technical difficulty. There was not yet adequate technology to machine the gears and wheels, etc. to the tolerances he needed. Often he had to design the machine tools he needed to do the work, as not even the tools existed yet. (But his work helped advance the machine tool industry in England.) He had trouble obtaining the necessary funding and eventually the government cancelled even the inadequate funding they were giving him.

```
510 PRINT "PEHR AND EDVARD
      SCHEUTZ"
520 PRINT "TABULATING MACHINE
      1853"
525 GOSUB 5000
```

But due to the publicity he got, the Scheutzes', a Swedish father and son team, read about Babbage's Difference Engine in the Scottish Journal *The Edinburgh Review* in 1834. They set to work on the problem and finished a working version of a similar machine in 1853. They called their machine the Tabulating Machine.

```
525 PRINT "CHARLES BABBAGE"
530 PRINT "THE ANALYTICAL ENGINE
      1837"
540 PRINT "AN ALL PURPOSE
      COMPUTER"
545 PRINT
550 PRINT "BORROWED FROM
      JACQUARD-LOOM 1805"
560 PRINT "ADA LOVELACE EXPLAINS
      MACHINE"
565 GOSUB 5000
```

In the meantime, however, Babbage had realized the necessity for a machine that could solve any mathematical problem, a machine that would be a general-purpose computer.

Babbage called this new machine the Analytical Engine and began working on it in 1837. He borrowed his conception for it from the Jacquard attachment to the weaving loom. The Jacquard attachment invented in 1805, made it possible to set a mechanical pattern or program to guide the shuttle of a weaving loom. The Analytic Engine was thus a machine that made great variation of use possible. Ada Lovelace, who helped to explain Babbage's ideas to a broader public, explained that the Analytical Engine could weave patterns by its programs, as the Jacquard-loom wove flowers and leaves in cloth.

Babbage continued to work on his Analytical Engine until his death in 1871. Because technology wasn't developed enough for him to be able to execute his idea, and because he had lots of trouble securing funding, he never succeeded in getting his Analytical Engine to work. But he had developed the conception of what later became two essential parts to the modern computer. He had understood the need for memory (CPU), which he called the mill, and he conceived of the need for an arithmetic/logic device, which he called the store. When working computers were finally built in the 1940's, they were constructed by studying Babbage's work and following the conceptual lines he had worked out 100 years before.

(To be continued in the next issue.)

#### **EDITORIAL STAFF**

Ronda Hauben  
William Rohler  
Norman O. Thompson  
**Technical Editor**  
Michael Hauben

The *Amateur Computerist* invites contribution of articles, programs, etc. Send submissions to: R. Hauben, P.O. Box 4344, Dearborn, Mi. 48126. Articles can be submitted on paper or disk in ASCII format, (IBM or Commodore.) A one year subscription ( 4 issues) costs \$5.00 (US). Add \$2.50 for foreign postage. Permission is granted to reprint any article herein, provided full credit, including subscription information is given and the reprinting is not for profit.