COMMONWEALTH OF MASSACHUSETTS

MIDDLESEX, ss. **SUPERIOR COURT DEPT**
CIVIL ACTION NO. 00-5159J

MICHAEL A. MINOVITCH,

Plaintiff,

v.

RICHARD H. BATTIN,

Defendants.

AFFIDAVIT OF PAUL PIERCE

I, Paul Pierce, on oath depose and state as follows:

1. I have an extensive background in computer software, with specialized knowledge in computer operating systems. I studied at the University of Wisconsin from 1972 to 1979, receiving a Bachelor's degree in Electrical Engineering and a Masters degree in Computer Science.

2. I worked at Intel Corporation from 1979 to 2002. From 1985 to 1995 I worked in the Supercomputing Systems Division where I became familiar with aspects of scientific computing.

3. In 2002 I retired to concentrate on my computer collection, which includes an IBM 650, IBM 709, IBM 7094, and several IBM type wheel printers, including the 407 accounting machine and 716 and 717 line printers.

4. I have personal knowledge regarding the matters set forth herein.

5. IBM manufactured a series of machines using a type wheel mechanism, which has 120 individual type wheels, one for each character position on a line, spaced

at exactly 10 characters per inch.[1] These machines share a characteristic font style and spacing characteristics. The spacing is very precise for a line printer, with nearly perfect horizontal positioning due to the fixed horizontal position of each type wheel and very good vertical position due to the slow speed of the wheel at the time of printing.

6. In the US, by far the most common of the type wheel machines was the type 407 accounting machine (accounting machines were also called tabulators), which originally was developed to prepare reports from punched cards. IBM punched cards contain 80 columns of information on each card. The 407 also could be attached to a 650 computer.

7. One common use of the type 407 simply was to make listings of card decks. This sometimes was referred to as an 80/80 list because the machine was set up with the 80 card columns wired to 80 adjacent print positions, so each card was listed on a separate line. This was the purpose of the type 407 in the keypunch room at the University of Wisconsin computing center in the 1970's.

8. The type wheel machines were fitted with a "tape-controlled carriage" to handle the paper, typically a type 922 or 923 with an F-2 tractor feed. The carriage and tractor feed usually were set to feed 6 lines to the inch. The paper came in

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[1] The type wheel was a later technology for IBM. Earlier accounting machines used a type bar technology. Examples of type bar accounting machines were the type 402, 403, 405, 418, 419, 421, and 444.

continuous forms, with holes along the sides for the tractor feed and perforations between pages. In scientific computing, people commonly used paper 14 7/8 inches wide, with pages 11 inches long. The carriage is capable of precise vertical and horizontal adjustment, so that printing could be lined up with boxes on specialized preprinted forms. The tractors could be loosened to move freely horizontally to accommodate different widths of paper and roughly position the paper. There are knobs for fine adjustments in both vertical and horizontal directions. This feature typically was not used in scientific computing, so that forms printed on different machines or even at different times on the same machine (after a new box of paper has been loaded and aligned) often did not line up.

9. A 407 in proper adjustment will maintain vertical alignment within 0.012" across the entire line, parallel to ruled lines on the paper to within 0.020" from one end to the other, and horizontal alignment within 0.008" between adjacent characters.

10. The 400-series accounting machines had a number of options to increase their capacity to create complex reports or to handle unusual forms such as labels. The product literature is devoid of any mention of a device that would keep track of the time and/or date, either as a standard feature or as an option. In reaching this conclusion, I reviewed the following manuals:

    a. "Reference Manual, IBM 407 Accounting Machine", IBM form

A24-1011-2, revised May 1965 (reprinted April 1966). Copyright 1950, 1951, 1953, 1957, 1959 by IBM.

b. "IBM Field Engineering Manual of Instruction, 407 Accounting Machine with 922 Tape-Controlled Carriage", IBM form 225-8090-5. Copyright 1952, 1953 by IBM.

c. "IBM Customer Engineering Maintenance Manual, 407 Accounting Machine", IBM form 225-6110-6, revised February 1962. Copyright 1953, 1959, 1962 by IBM.

d. "IBM Customer Engineering Instruction - Reference, 407 Accounting Machine Special Features", IBM form 225-6471-0. Copyright 1961 by IBM.

e. "IBM 402, 403, and 407 Computing Accounting Machines; IBM 407, 421, 444, and 447 Computing Accounting Machines for IBM World Trade Corporation", IBM form A24-3475-5, Sixth Edition, June 1968.

11. The IBM 650 was extremely slow by today's standards, and quite slow compared to other, larger computers of its day. It has a magnetic drum main memory, so that the timing of the computer is determined by the mechanical speed of the drum, which is 12,500 RPM. IBM's other scientific computers of the time (the 704, 709 and 7090) have magnetic core memory that operates at electronic speeds.

12. To evaluate the relative speed of the 650 compared to the 7090 for scientific calculations of the kind that were likely required for orbital computation in three dimensions, I analyzed a very small computational kernel consisting of a three-element dot product. Both machines use arithmetic algorithms that vary in time according to the data values used, so it is not possible to calculate exact timing even for a given simple kernel. However, it is possible to estimate expected

average times. Using optimum coding techniques as described in the manual for the 650, and assuming the machine had the floating point hardware option, it appears that the kernel typically would execute in about 10 revolutions of the drum, yielding a rate of about 21 dot products per second. The 7090, with a core memory speed of 2.18 microseconds per access, could perform about 7700 dot products per second. Thus, for this benchmark the 650 is about 370 times slower than the 7090.

13. The basic 650 consists of the computer cabinet, a cabinet containing the power supplies, and a type 533 card reader and punch. To run a problem on the basic computer, an operator must keypunch a code and data onto punched cards and combine these with cards containing any library software needed, placing the combined deck in the card reader. The operator then must operate the switches on the computer to make it read the cards and punch the results into new cards. The operator then could take the punched deck to, for instance, a type 407 machine wired for an 80/80 list to print them out.

14. The optional equipment for the 650 included a 537 card reader and punch that punches the results onto the same cards it read; a way to attach a 407 so that results can be printed directly; various electronic options (including the hardware floating point option) to enhance its computing ability; and tape drives or a disk drive. There is no mention in any of the product literature of a clock device that

keeps track of the date and time, either as a standard feature or as optional equipment.

15. In preparing this Affidavit, in addition to the product literature identified in Paragraph 10, I reviewed a Xerographic reproduction of the two page computer printout which allegedly evidences Dr. Battin's work on January 26, 1961, a page explaining some of the numbers on one of those pages, a 1994 paper by Richard H. Battin entitled On Algebraic Compilers and Planetary Fly-By Orbits, and the February 9, 2005 deposition transcript of Richard H. Battin.

16. On page 6 of the 1994 paper, Dr. Battin states the following:

> It was very exciting indeed when the double fly-by finally worked. A large number of iterations on the IBM 650 had been required. The initial conditions for each iteration had to be key-punched and inserted in the card-reader. The output was produced on punched cards which then had to be listed on an IBM tabulator. The trial failed if the spacecraft were required to fly beneath the surface of either planet to obtain the necessary energy exchange to carry it to the next planet.

It should be noted that this paragraph describes the normal operating procedure described above for a basic 650, one without a directly connected 407 printer or tape drives.

17. The first of the two pages of the computer printout contains a single line of text as follows (not to scale), occupying 106 character positions.

92656 TIME CONVERSION 0000 01-26-61 24

The second of the two pages of the computer printout contains the following text,

occupying 63 character positions. Underneath the printing is written "Double reconnaissance trajectories."

14440000 52 -63260000 54 -12628000 55 -50510000 54 30000000 51
43077363 50 28253000 55 26980000 54 33500000 53 20000000 51
20000000 50 50000000 50
14870774 52 23564000 55 15771000 55 -12740000 54 20000000 51
39494105 50 19624000 55 -17633000 55 17900000 54 40000000 51
20000000 50 40000000 50
15265715 52 16713000 55 -20418000 55 17360000 54 40000000 51
43479526 50 -40370000 55 -73030000 54 18360000 54 30000000 51
20000000 50 50000000 50
81000000 51 -79070000 54 -13922000 55 39850000 54 30000000 51
41961776 50 29837000 55 11640000 54 -63130000 54 20000000 51
20000000 50 50000000 50
85196178 51 23529000 55 18335000 55 -64530000 54 20000000 51
54542003 50 60610000 54 -14285000 55 29570000 54 40000000 51
20000000 50 60000000 50
90650378 51 86590000 54 -13164000 55 11150000 54 40000000 51
89504715 50 39120000 55 51200000 53 28390000 54 30000000 51
20000000 50 10000000 51

From the font and the precise spacing it appears that both pages were printed on IBM type wheel printer(s).

18. The first page is more than 80 characters wide. As a result, in my opinion, it was not printed from punched cards. Although the tabulator could have been wired to print something (e.g. a page number) outside the area printed from the cards, this does not appear on the second page. Therefore, it is reasonably certain the pages were not produced in the manner described by Dr. Battin in the 1994 paper.

19. In his deposition, Dr. Battin claims that he keypunched a set of cards and listed them on an accounting machine to produce the second page, and that the

accounting machine automatically produced the first page. While the second page could have been produced in this manner, it seems odd that anyone doing this for the purpose of making a record of important numerical values would have used the peculiar floating point notation of the IBM 650.

20. In my opinion, the first page was not produced automatically by an accounting machine. First, there is no evidence of any accounting machine feature to keep track of the date, so any date printed by such a machine would have originated from cards or from control panel wiring, both of which must be punched or set up manually. It is possible that an accounting machine might be able to print something automatically. This would be wired into the control panel, a kind of primitive form of programming. Generating information that does not come from a card is inconvenient, as it must be wired from "character emitters" with splitters for any duplicate characters on a line. Thus, one would expect the information printed on such a line to be spare and well thought out. The line on the first page, with the relatively lengthy and obtuse "TIME CONVERSION" and all the extra numbers, seems very unlikely. Again, if this wiring was to indicate the date, someone would have to manually change the wires every day to bring the information up to date, meaning also that it would be relatively easy to change the wires for any particular run.

21. The phrase "TIME CONVERSION" does not appear in any of the product

literature. Since the 650 does not have a date or time clock device, it is no surprise that I did not find any reference to time and date headings on the output of 650 programs.

22. On March 15, 2005 I inspected the originals of the two pages of the computer printout. I placed the two pages one over the other, with the first page on top and the feed holes on either side lined up precisely. With the two pages clamped in this position to a piece of clear plastic and with the pages lit from the back, it is easy to see the printing on both pages superimposed one on the other. I observed that the single line on the first page and the first line on the second page did not align. The line on the first page was a little less than the character height below the corresponding line on the second page, and slightly to the right. From analysis of photographs, the vertical misalignment is 0.036" or 22% of the line spacing, and the horizontal misalignment is 0.012" or 9% of the horizontal character spacing. This shows conclusively that the two pages were not printed on the same run through the printer because this type of printer never would produce output this far out of alignment.

23. I inspected two other aspects of the original pages. To see if there was any indication of problems with the paper feed, I inspected the feed holes on either side of each page. I found that on both pages the feed holes generally were in good condition. The holes on the left side of both pages were wrinkled slightly

toward the outside edge, and the holes on the right side of both pages were wrinkled slightly toward the outside edge at a slight angle toward the top of the page. There was no tearing or significant deformation of the feed holes. It appears that at the time each page was printed, the tractor feed was adjusted slightly too wide, a common situation especially with inexperienced operators, and the right side of the paper might have been dragging a little, as for instance if the paper box was offset to the left in back of the printer.

24. I also inspected the quality of the printing. On both pages all characters are lighter at the bottom. According to the maintenance manuals, this indicates that the platen might have been adjusted slightly too high.

25. The similarity of the feed holes and print quality indicates that it is possible, though not certain, that the pages were printed on the same printer. However, the misalignment between the top lines shows that they were not printed at the same time. If they were printed on the same printer, it most likely would have been from different boxes of paper. Typically, in loading a new box, the operator first would loosen the tractor on one side, feed in the paper and clamp it in the tractors, then pull the loose tractor to the side to stretch the paper flat across its width and tighten the loose tractor. This step leaves the new paper in approximately, but not exactly, the same horizontal position as the previous box. The operator would then disengage the platen clutch and turn the large knob on the right side of the

carriage to position the paper roughly at the top of the form and use the vernier (a part of the knob) to position the paper more closely. The use of the vernier destroys the vertical alignment between the previous box of paper and the new box. The lack of any preprinted rules (lines) on the paper means the operator need not line up the paper very precisely, and must judge the position from the perforations. Since forms alignment was not critical for scientific work, there is no reason for an operator to bother to align the paper carefully.

26. Based on my education, training and experience, and on my examination of the product literature, I hold the following opinions to a reasonable degree of professional certainty:

a. Both pages appear to have been printed by an IBM type wheel printer such as the 407, 408, 409 or 447.

b. The pages were not prepared in the manner described by Dr. Battin in the 1994 paper because the single line on the first page is too wide.

c. The pages were not printed together in one run because the characters do not line up vertically between the two pages.

d. The date heading on the first page was not produced automatically by an IBM 407, 408, 409 or 447 accounting machine because none of them had a date or time clock device.

e. The date heading on the first page was not produced by an IBM 650 because the 650 did not have a date or time clock device.

f. The second page could have been printed on an IBM 407, 408, 409 or 447 accounting machine from a deck of punched cards.

g. The second page appears to contain numbers in the form used with the IBM 650.

Signed under the penalties of perjury this _____ day of April, 2005.

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Paul Pierce