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COMMONWEALTH OF MASSACHUSETTS

MIDDLESEX, SS. SUPERIOR COURT

- X

MICHAEL A. MINOVITCH

Plaintiff,

v. Civil Action No. 00-5159J

RICHARD H. BATTIN, ET AL.,

Defendants.

- X

DEPOSITION of WALTER M. HOLLISTER
Tuesday, February 1, 2005
Hermes, Netburn, O'Connor & Spearing, P.C.
111 Devonshire Street
Boston, Massachusetts

Reporter: Katherine A. Tevnan, RPR/CSR

APPEARANCES:

HERMES, NETBURN, O'CONNOR & SPEARING, P.C.
(By Peter G. Hermes, Esq.)
111 Devonshire Street
Boston, Massachusetts 02109
617-210-7730
for the Plaintiff.

PALMER & DODGE
(By Jeffrey Swope, Esq.)
111 Huntington Avenue
Boston, Massachusetts 02199
for the Defendant.

ALSO PRESENT:
Michael A. Minovitch

I N D E X

E X H I B I T S

*Original exhibits retained by Attorney Hermes

P R O C E E D I N G S

MR. HERMES: I can call you by a number of titles. Tell me what you would prefer.

THE WITNESS: You can call me Walt if you like.

MR. HERMES: I wouldn't do that on the record. Is it professor or doctor?

THE WITNESS: It doesn't make any difference.

MR. HERMES: Pick one then. It is your choice.

THE WITNESS: Professor.

MR. HERMES: Fine.

WALTER M. HOLLISTER

a witness called for examination by counsel for the Plaintiff, being first duly sworn, was examined and testified as follows:

MR. HERMES: Mr. Swope, with respect to stipulations? I would propose we go according to the rules, but I am willing for the witness to read and sign under the pains and penalties of perjury if you agree.

MR. SWOPE: I agree with that.

MR. SWOPE: Objections as to form and motions strike reserved, or would you prefer they be --

MR. HERMES: I prefer they be made now.

DIRECT EXAMINATION

BY MR. HERMES:

Q. For the record would you please state your name?

A. Walter Hollister, H O L L I S T E R.

Q. What is your home address, sir?

A. 139 Bedford Road in Lincoln, Massachusetts 01773.

Q. What is your date of birth, Professor Hollister?

A. 22 November 1930.

Q. Are you currently employed, sir?

A. Am I employed? Is that the question?

Q. Yes.

A. No. I am retired as professor emeritus from MIT.

Q. When did you retire, sir?

A. Officially retired in 1996.

Q. Did you cease having duties at MIT sometime

prior to 1996?

A. No. In fact, I taught for an additional five years and was paid half-time for that.

Q. Was there some particular reason why you stayed on for only five years?

A. It was a golden handshake and that's all they would give us. We could stay longer, but we couldn't be paid.

Q. How long were you employed by MIT?

A. I will have to tell you that approximately, I joined the faculty in 1963 and retired in '96.

Q. Did you have any other full-time employment other than your employment at MIT with the exception of your military service?

A. As a consultant. It was not full time but it was, well, we were authorized a day a week to consult. I doubt that it ever was that much on a consistent basis.

Q. In what field did you do consulting?

A. The areas I was considered to have expertise in. I worked in astrodynamics field for perhaps eight, nine years. I worked in the air traffic control field for the remainder of my career.

Q. You were in the military service, were you

not?

A. Yes. I served in the naval reserve as a naval aviator for 22 years.

Q. When did you first go into the naval reserve?

A. I joined the navy on the fourth of April in 1954.

Q. You were on active duty until when, sir?

A. April 4, 1958. Then later --

Q. You were invited back I take it?

A. Yes. Over the Berlin crisis. I don't know the exact dates of that but it was approximately parts of '61, 1961 and '62.

Q. Do you recall the months when you went back in or the month you went back in?

A. I can only give you that approximately. It was approximately September of 1961 that I went in, I believe. But I can't say that that's exact.

Q. Your best memory as you are sitting here this afternoon was it was September?

A. Yes. But I am not confident of it.

Q. I understand that. When were you released from active service?

A. I believe it was one year later. It was

meant to be a year of service.

Q. Did you retire from the navy?

A. Yes. As a reservist.

Q. When was that?

A. It would have been 22 years from 1954.

Q. Approximately 1976?

A. Yes.

Q. What was your rank on retirement?

A. Captain.

Q. Are you familiar with the relationship that existed at one time between MIT and the MIT Instrumentation Laboratory?

A. Yes.

Q. Can you describe that for me, sir?

A. My relationship?

Q. No. The relationship between MIT and the MIT Instrumentation Laboratory.

A. Yes. The MIT Instrumentation Laboratory was founded by Dr. Stark Draper. I don't know the dates of these various events. But roughly at the time of the Vietnam War there was a question raised as to whether MIT should be sponsoring classified research at the Instrumentation Lab. The decision was made that the institute should divest itself of the

Instrumentation Lab and it was I think at that time that the name changed to the Charles Stark Draper Lab.

Q. Does the, do the Draper Lab -- does the Draper Lab now function independently of MIT?

A. There is a very strong relationship between them. In other words, we draw some of our faculty, associates or teaching people from the Draper Lab. Dr. Battin, for example, for a number of years was employed by the Draper Lab but was teaching within the Aeronautics Department.

Q. Was that to your knowledge both before and after the separation of the Draper Lab from MIT?

A. Yes. Dr. Battin is still teaching, as a matter of fact. His role though now, he has retired from the Draper Lab. He now, I believe his appointment now, his appointment had been at least at one time an adjunct professor. I am not certain of what his current appointment is.

Q. In what department did you hold appointments at MIT or what department or departments?

A. During my time as a professor it was always in the Department of Aeronautics and Astronautics.

Q. Professor Hollister, let me show you a copy

of a paper, the title is Periodic Swing-by Orbits Between Earth and Venus. I ask you if you would take a look at that, please. Is that a paper which you wrote with Michael Menning, M E N N I N G?

A. That's correct. Michael Menning was a student at the time.

Q. In the first paragraph in the introduction about five lines down there is a reference to Michael Minovitch, is there not?

A. Yes.

Q. That reference continues to the end of that first paragraph, does it not?

(Pause)

A. I think that would be correct. Let me qualify that. The last sentence refers to reference 9, which was a reference of my own.

Q. Fair enough. I appreciate that, sir.

My question is, the statements made concerning Dr. Minovitch and beginning it was Minovitch, however, who first recognized the fundamental role which the planetary fly-by can play in trajectory design. My question, sir, is, are the statements you made concerning Dr. Minovitch in this paper accurate when you made them?

A. No. I don't think so. Because --

Q. I think you answered my question. You answered my question. I believe the answer to my question was no. I will ask you one more time.

The statement that you made in the first paragraph referring to Dr. Minovitch. My question is, sir, were they accurate when made in this paper?

A. I believe the word first makes it inaccurate.

Q. When you wrote this paper did you believe that the word first should not be in the paper?

A. The words that were written there were a paraphrase of the report of the reviewer. It would appear, it appeared to me that if I did not include this information in the paper the publication of my paper would be denied.

Q. Do I take it, sir, you included in your paper something you believed was inaccurate in order to have the paper published?

A. No. It was my understanding that Dr. Minovitch had been primarily interested in trajectories to the outer planets. As such I was thinking in terms of the work that he had done in using the fly-bys of the outer planets to go further

and further in the solar system and ultimately to escape from the solar system.

Q. Did you ever state in writing to anyone that the statements contained in the first paragraph concerning Dr. Minovitch were untrue?

A. No.

Q. Apparently when this paper was published you believed the use of the word first was inaccurate, correct?

A. I think the words that I used were a paraphrase of what was in the reviewer's report.

Q. Did you anywhere in this paper credit the reviewer for any words that you put in the paper?

A. No.

Q. Are you walking away from this paper now and saying these are not your words?

A. I don't think I understand your question.

Q. This paper was published to a portion of the scientific community, was it not?

A. Yes.

Q. Apparently you published something in this paper as to which you had, you either knew was untrue or had doubts as to whether it was true; is that correct?

A. I don't think that I could agree with that statement.

Q. Did you know whether in 1970 when this paper was published whether Minovitch was the first, whether Minovitch first recognized the fundamental role which planetary fly-by can play in trajectory design?

A. This question is extremely complicated because there were several people early on who had made similar proposals. They preceded -- it would go back as far as Hohmann and Crocco. Before there was even the capability of carrying out these kinds of missions. To identify who is the actual first person that did this would be a very, very difficult thing to establish and credit should probably go to many people who contributed. Certainly Dr. Minovitch was one. Dr. Battin was one. A number of other people, probably most of the authors that were referenced by either of it.

Q. Why didn't you say that in here if you knew then that it might be or that Hohmann had made a contribution and Crocco had made a contribution and Battin had made a contribution and Minovitch had made a contribution, why didn't you say that rather

than use the word first with reference to Minovitch?

A. As I said before, the word first was suggested by the reviewer.

Q. You could have said no, couldn't you?

A. Possible. But then I wouldn't have been able to publish my paper.

Q. Was it more important to publish the paper or more important to be more accurate as your own mind showed you that -- the right of it?

A. I don't know how to make that judgment.

Q. You apparently made it here, did you not? You made it here by using the word first?

A. That's your statement.

Q. You did use the word first, did you not?

A. Yes.

Q. May we have the Periodic Swing-by Orbits marked as Exhibit No. 1, please.

(Exhibit one marked for identification)

Q. Referring to the last page of Exhibit 1, reference number four refers to a paper by Michael Minovitch with a date of August 1961, does it not, Professor Hollister?

A. Reference four you said?

Q. Yes.

A. That is by Ross.

Q. It is six, is it not? Referring to number six?

A. Yes.

Q. Is that paper by Minovitch written in 1961?

A. That's what is printed here, yes.

Q. When did that paper first come to your attention?

A. In the review of the paper we were just looking at.

Q. Do you recall whether or not other papers by Dr. Minovitch on similar subjects had come to your attention at any earlier time?

A. To the best of my recollection, I had no knowledge of Dr. Minovitch's work prior to that review.

Q. If you look at the first page of Exhibit No. 1, down at the bottom there is an entry, it looks like a note that says received August 14, 1969. I am talking on the lower left, sir. Then there is revision received June 11, 1970. Was the reference to Dr. Minovitch in the original version of the paper

A. No. Not to my knowledge.

Q. Was it first put in the paper at the time of the June 1970 revision?

A. I believe that's correct.

Q. Have you had occasion to serve as a thesis supervisor for graduate students at MIT?

A. As a supervisor?

Q. Yes.

A. Yes.

Q. When you serve in that role do you review the papers written by students?

A. Yes.

Q. Do you refer the -- do you look at the sources that they cite?

A. If you are asking do I read all their references, I would say perhaps not.

Q. Do you make it a practice, did you make it a practice to look at the table which includes the references?

A. You are talking now about references that students have in their papers?

Q. Yes, sir.

A. I would be more likely to speak with the author, ask him about it. Unless the reference was

something that would be pertinent to my work.

Q. Do I take it then that if you had a student, for instance, who did a paper, in a thesis where you were the supervisor in say 1968 that made reference to Dr. Minovitch that you would not necessarily have become aware of a paper cited by the student in the thesis?

A. If I understand your question correctly, it is possible that there might have been a student aware of Minovitch and I didn't learn of it. Is that the point you are trying to make?

Q. Yes.

A. That could be, certainly be possible.

Q. Can you tell me, sir, what did you do in preparation for your deposition here today?

A. I reviewed documents that I had that I thought were pertinent. One was the notes that had a date and the information about Dr. Battin's work with two planet fly-bys. I looked at the copy which I have of the review of that, of this paper (indicating)

Q. By this paper you are referring to Exhibit 1, sir?

A. I think that's what you called it.

I looked in Dr. Battin's book about the orbit which was the same one that was in my notes. Perhaps you could help me as to if you are looking for something very specific.

Q. I am looking, sir, to find out simply what it is that you may have looked at in preparation for this deposition. I think you told me that you looked at two sets of notes. I will show you some and ask you to identify them. Are you represented by counsel here this afternoon?

A. No.

Q. Did you meet with Mr. Swope prior to your deposition?

A. No. But we spoke on the phone.

Q. What did you speak about?

A. He told me what to expect and advised me the most important thing I could do is to speak the truth.

Q. What did he advise you to expect?

A. He said that there might be some question about this paper (indicating)

Q. Exhibit No. 1?

A. Exhibit No. 1. And that there might be a question about a statement in my doctoral thesis,

which I also looked at.

Q. Let me show you a document, sir, it is dated May of 1963. Do you recognize this as a copy of your doctoral thesis that you did at the Massachusetts Institute of Technology?

A. Yes, I do.

Q. Do you recall what the standard was for a thesis for a doctor of science degree at MIT in March of 1963, in May of 1963?

A. No, I don't remember that.

Q. In your work at MIT as a thesis supervisor have you ever applied to a student's work a particular standard concerning a thesis?

A. I think it is a matter of judgment.

Q. Professor Hollister, is it a requirement of a thesis that it contain, a doctoral thesis at MIT, that it contain an original idea or deal with an original subject or research in an original subject?

A. That's usually stated.

Q. Was that the case with respect to your doctoral thesis?

A. Yes, I think there were original things in it.

Q. Was it required that there be certain

original things in your doctoral thesis?

A. I have no way to state that without referring to the rules at that time. Which I don't recall.

Q. You said you believed there were certain things that were original in your thesis. Can you identify them for me?

A. Well, the main thrust of the thesis was to have a very simple model, not highly accurate at all, to understand the relatively complicated trajectory analysis for the purposes of a manned mission to Mars.

Q. What original ideas were contained in your thesis as you recall in that regard?

A. Well, it was a bit unconventional, but I used a linearized model of the orbital dynamics which would, was only to realize how the orientations of the planets would be critical in when you chose to launch an expedition to Mars.

Q. In what way, sir?

A. Well, if you are going to Mars and you use the minimum energy trajectory to get there, it is usually referred to as an Hohmann trajectory. You arrive at Mars in a position such that you have to

wait longer than a year before you are in a position to make a similar trajectory back to earth, which makes the total mission several years long. In the interest of trying to get a shorter mission, one in which you can return to earth relatively early after your arrival at Mars, it is necessary to do something that allows you to get ahead of the earth so that when you return you will be able to depart Mars shortly after you arrive.

Q. Were you able to come up with a method by which that could be accomplished?

A. Well, I introduced what was called a bi-elliptical approach. Bi-elliptical trajectory. That means that you have a thrust and a velocity change roughly halfway to Mars and the orbit would take you closer to the sun originally, and then the velocity change, and arriving at Mars in a position where you would be able to return to earth directly.

Q. Would you look at page seven of your thesis? Just above section 1.3 there is a statement, it should be noted, however, that the author has found no mention in the literature of the specific mission suggested in this work, namely trips to Mars via bi-elliptical transfer or via a Venus encounter that

includes a significant velocity change near Venus. Do you see that sentence, sir?

A. Yes.

Q. I think you told me something about bi-elliptical transfer. What is in your thesis with respect to a Venus encounter that includes a significant velocity change near Venus?

A. Well, the efficiency of a velocity change is greater when you are moving fast. The energy of an orbit, you have to increase the energy to get to Mars. The energy in an orbit is proportional to the velocity squared. What that means is that the change in energy is proportional to the velocity times the change in velocity that you apply. Therefore, if you apply the velocity change at high speed, you increase the energy more efficiently than if you do it at slow speed. If you went to the vicinity of Venus, which would be your closest point to the sun and at high velocity, that would be a very efficient time to apply a velocity change. If the planet weren't there you could still do it but it would take more velocity change than it would if the planet were not there. It would be more, it would take more velocity change if Venus were not

there than if Venus was there.

That direction of looking at velocity changes at Venus during that fly-by was the subject of subsequent research where we actually made contours of the, I think we plotted the energy as a function of the velocity change. All in the -- with the goal of more efficient ways to get to Mars without having to wait the several years before your return.

Q. Did the Venus encounter that you discussed in your thesis include a free-fall coasting trajectory?

A. No. That would be a special case.

Q. Why was it a, why was that special?

A. No velocity change. No velocity added in terms of a rocket thrust.

Q. If I understand correctly, scientists such as yourself and others whose work you looked at were trying to find a more efficient way to travel to Mars rather than a direct mission to Mars; is that correct?

A. Yes. I think the reason is that in order when you get to Mars you can return to earth without waiting while Mars goes around the sun.

Q. There were also issues with respect to efficiency and usage of fuel and minimizing the usage of fuel where necessary?

A. Yeah.

Q. One of those issues had to do with just the amount of fuel needed to lift off the earth to get, to make a mission to Mars, correct?

A. Yeah.

Q. Scientists were looking for better ways to get to Mars than a direct trajectory from the earth to Mars, correct?

A. Yes.

Q. One of the ways that you discussed in your thesis was the bi-elliptical transfer, correct?

A. Yeah.

Q. Another way was a trip to Venus with a velocity change near Venus?

A. Yes.

Q. The velocity change near Venus by what was, what was to be by way of an engine or thrust developed on the spacecraft itself, correct?

A. Yes.

Q. When you say on page seven that you found no mention in the literature of the specific mission

suggested in this work, that is speaking about your thesis, you were not then aware of Dr. Minovitch's August 1961 paper, were you?

A. That would be correct.

Q. Were you then aware at the time you wrote this statement of the work of Richard Battin?

A. Yeah.

Q. Were you aware of lecture notes dated August of 1961 captioned lecture notes on the trajectory problem as it relates to the mission for interplanetary flight?

A. I don't know.

Q. Let me show you that document, sir. It is identified as being by Richard H. Battin, Halcomb, H A L C O M B, Laning, Jr.

A. I believe these must have been written following the class that I took the course with Dr. Battin. Do we have the copy of those -- well, you are asking if I have seen this document?

Q. Yes.

A. I cannot remember.

Q. My more specific question was, had you seen that document before you wrote your thesis?

A. I don't think I have seen this specific

document but I can't be specific of that many years ago.

Q. Let me ask you another question. In your thesis on page 148 you make reference to, it is three pages from the end, sir. Page 148. Reference 34 refers to Battin, R.H, astronautical guidance and a date of December 1963. Do you see that, sir?

A. Yes.

Q. I believe, Professor Hollister, if you checked that book you would find that the lecture notes are one of the chapters in that book?

MR. SWOPE: Objection to the form. Question.

MR. HERMES: I don't want to --

MR. SWOPE: I want to note my objection. You may answer.

Q. Is it possible, sir, that if that were the case that you have seen the lecture notes that are in front of you?

A. I certainly have seen that book of Dr. Battin's, yes.

Q. Do you recall whether or not that book of Dr. Battin's spoke of an Earth, Venus, Mars, Earth mission?

A. Yes, it did.

Q. If you look at -- let's do some housekeeping. Let's mark your thesis as Exhibit No. 2, please.

MR. SWOPE: Could I note for the record there seems to be at least one marking on that of a red check.

MR. HERMES: Yes, there does appear to be.

MR. SWOPE: That was on it when it was presented to Professor Hollister. Is that correct? Or did you enter the red check?

A. I did not render it.

MR. HERMES: There may be other red checks and for the record they are none that Professor Hollister has made on the document.

(Exhibit 2 marked
for identification)

MR. HERMES: May we also have marked as Exhibit No. 3 the lecture notes on the Trajectory Problem.

(Exhibit 3 marked
for identification)

MR. SWOPE: Can we say if there are any

checks?

MR. HERMES: Yes.

MR. SWOPE: Now that I look at Exhibit 1 there is a red mark on that. The same stipulation.

MR. HERMES: Yes.

Q. Professor Hollister, Exhibit 3 are the lecture notes for class 16.46, the document bears the date of August 1961. I direct your attention to page 49 of that paper. I believe the subject of pages 49 and 50 and the accompanying slides are Earth, Venus, Mars, Earth trajectories. My question to you, sir, is, when you wrote your thesis were you aware of the information contained on those pages?

MR. SWOPE: Object to the form of the question. You may answer.

A. Yes.

Q. Were you aware of the information contained?

A. Yes. I would point out that the Earth, Venus, Mars trajectory described here did not have a velocity change in Venus.

Q. Understood.

A. Not by a rocket. Velocity changes would have been by the interaction with the planet.

Q. Is that the reason why, sir, you -- let me

ask you this question. Did you consider when you made the statement that you found no mention in the literature of the specific mission suggested, that the distinction between what you were suggesting and what had been written on Exhibit 3 was the fact that there was no rocket thrust at Venus?

A. That's correct. That statement which you referred to earlier, that there was no work to my knowledge on those type of trajectories was because they did not include a Delta V, provided by the rocket, either on bi-elliptical transfer or in the vicinity of Venus.

Q. Do I understand, sir, that had you known about Dr. Minovitch's paper you would not have changed the statement made on page 7 because Dr. Minovitch was not speaking in his paper, his 1961 paper, about a Delta V at Venus?

MR. SWOPE: Objection.

A. That's too problematic a question.

Q. Why do you find it problematic?

A. It was 40 years ago. How do I know what I would have done?

Q. Did you consider -- let me ask you now, do you consider that the Earth, Venus, Mars, Earth

mission described on pages 49 and 50 of Exhibit 3 to be similar to the types of trajectories discussed by Dr. Battin in his 1961 -- Dr. Minovitch in his 1961 paper?

A. I can't remember. I would point out to you that, it may be stated here, I believe it was in Battin's book that he thought of these as sort of interesting trajectories but that they weren't very practical in that the window, the launch window in time was so small that if by any chance you missed it would be another six years before you would have an opportunity to do the same mission. So he cited these double planet fly-bys and calculated them. But he pointed out that he didn't think they were practical. In fact, I think the statement is this one -- here it is. It is sad to report that those double-reconnaissance trajectories are little more than astronautical oddities. Unfortunately the launch time tolerances appear to be far too severe for them to be exploited with current technology. Unforeseen delays in the countdown of even a few days would necessitate, necessitate a six year postponement in the mission.

Q. You were reading from page 50 of Exhibit 3,

correct?

A. That's correct, yeah.

Q. Has that proven to be the case?

A. Well, it is 40 years later. It was certainly true at the time, I think. In conjunction with my thesis, it was the assumption that those probably wouldn't be practical orbits and that was the reason I was looking at the bi-elliptical orbits.

Q. As it turned out, in fact, those are practical orbits?

A. Now?

Q. Yes.

A. No.

Q. Isn't it a fact based on what is known now they are practical orbits?

A. I wouldn't know that.

Q. Why is that, sir?

A. I haven't been in this field now for 20 years.

Q. Tell me what field you were in or have been in in the last 20 years, sir?

A. Air traffic control.

Q. Anything specific concerning that, sir?

A. I was working at Lincoln Lab and the primary interest was collision avoidance system. The collision avoidance system now in all airlines was developed there then.

Q. Prior to the last 20 years what field did you work in?

A. Well, at the time of my doctoral research was when I first entered the planetary, interest in planetary orbits. That continued about, it was roughly when the Apollo missions were, I don't say complete, but most of the engineering was done and the funding in that area dropped. I imagine Dr. Minovitch would remember the difficulty in getting funds then. I decided that a change in the research area --

MR. MINOVITCH: Around 1960 --

MR. HERMES: You are not the witness today. You will get your own turn.

Q. Did you move to a different field then at that time when the funding dried up?

A. That's when I got interested in air traffic control. I spent at least a day a week at the Lincoln Laboratory.

Q. In connection with your thesis, Exhibit No.

2, did you have occasion to discuss your ideas with Dr. Battin?

A. I don't believe so. When I was recalled into the service, before I went into the service, I had talked with him about doing a thesis on interplanetary guidance. Then I was called into the service and I think he was a little disappointed that I wasn't there after I had talked with him about doing work with him. My advisor for the thesis was Dr. Wrigley who was the chairman of the what was called the interdepartmental instrumentation doctoral program.

Q. Now, in your thesis on page 3i you state that the staff of the MIT Instrumentation Laboratory has been extremely helpful. You indicate Dr. Richard H. Battin, among others, had provided technical advice. Do you recall what technical advice it was that he provided?

A. Yes. Someplace else in the thesis it is much more specific. But he had a computer algorithm which determines the semi-major axis of the orbit from the time of flight. That was a rather stellar piece of work that he and Dr. Laning did. He gave me that, the code for that. And I used it.

Q. Let me show you page 71 of Exhibit 2. There is a specific reference in there to Dr. Battin?

A. That's exactly what I said. Dr. Battin's kind permission the iteration routine to obtain the semi-major axis of the transfer ellipse from the time of flight was taken directly from a computer program which he wrote.

Q. Can you describe for me in words I can understand what that program did?

A. It is in Dr. Battin's book. It is a description of that.

Q. Can you describe it to me, sir?

A. No. Not in words that would be simple. I doubt that I could reproduce it now after 40 years without referring to the book.

Q. That wasn't a program for calculating gravity-assist trajectories?

A. No. It was purely a mathematical thing working with Kepler's equation. The importance of it was that you wanted to know orbits in terms of the time of launch and time of arrival. Subtract those two and you have the time of flight. The question was, how do you get properties of the transfer ellipse from the time of flight? This

obtained the semi-major axis of that ellipse as a function of the time of flight.

MR. SWOPE: I think you just explained it to him in terms he can understand.

(Discussion off the record)

Q. I put before you a document, the first page of which is handwritten and bears a date of 23 May 2000 captioned To Whom It May Concern. It appears to be your signature at the bottom of the first page. Do you see that, sir?

A. Yes.

Q. Do I understand, sir, that the first page of that document is in your handwriting or in your hand?

A. Yeah.

Q. What are the attachments to the document dated 23 May 2000?

A. These are all of the notes from the course I took from Dr. Battin. This should answer the question of what the date was of that.

Q. I will help you out in a minute if you can wait. I want to identify the document at least initially.

A. Would you repeat the question you are

waiting on me to answer?

Q. The cover page is something which you wrote in May of 2000, correct?

A. Yes.

Q. The rest of the pages are notes from a course that you took at MIT in May, in 1960, sir?

A. That's correct. Well, the course was the spring term of 1960. It started in February and went through to May.

Q. What were the circumstances under which you wrote the 23 May 2000 first page?

A. That was a time at which Dr. Minovitch was present and he had an expert analyze the ink on my notes to see if they in fact were written somewhere near 1960.

Q. What occasion was that? Where did that take place?

A. I believe it was in the Draper Lab, wasn't it, Doctor?

MR. MINOVITCH: Yes.

MR. HERMES: No. As much as you gentlemen are used to certain colloquies, this a lawyer colloquy. I ask the questions, you give the answer, Professor Hollister.

A. I am not willing to state under oath exactly where we were. I thought it was in the Draper Lab. The persons present would have been Dr. Minovitch and I believe there was another student that had taken the course from Dr. Battin also.

Q. Larry Brock?

A. Yes. Larry Brock.

Q. Was there a fellow there by the name of Lyter, L Y T E R?

A. There might have been, but I don't recall that name.

Q. Do you recall whether he was the expert or not?

A. No. Was that his name? He apparently is well-qualified in the study of ink dating.

Q. How did you come to be there on that occasion? Did someone ask you to bring your notes?

A. Dr. Battin had told me of his concern, that he wanted evidence of the fact that he had done the work. I said well, you know, I will have my notes from the course and they are dated. I have a tendency to keep all my notes from graduate school.

Q. Do you have your notes from all your graduate school courses?

A. Ones that I was -- found useful. Certainly not all of them. Unlikely I would keep notes from a literature course. From many of the engineering courses I still have.

MR. SWOPE: You are offending present company.

MR. HERMES: Haven't you found the students with the ability to communicate in English by the written word is a great talent, sir?

A. Yes. I can remember most of that. Most of the technical material it is hard to remember.

Q. Where did you keep the notes, sir?

A. They are in my study at home.

Q. What form does the original take?

A. It is a loose-leaf, not loose-leaf. It is one of those binders that has a piece of metal that -- what I would do is, at the end of each course if I felt it was useful keeping the notes, I would put them in that binder, then deposit them in my library at home.

Q. Is the binding similar to this?

A. Almost similar.

Q. I would call an ACCO binder?

A. Yes.

Q. You keep the original of those notes in your home?

A. Yes.

Q. You have other notes from 1960 and other years?

A. Yes.

Q. Do I take it, where -- were holes punched in the paper?

A. Yes.

Q. On what side?

A. It would be on the left. I have to be careful. In the interest of conserving paper I may have had some of them written on the back.

Q. Do I take it on some pages you wrote on both the front and back of the pages?

A. I believe so. I don't know. If that's important I would really have to look.

Q. You still have the document in your possession?

A. Yes.

MR. HERMES: May we have the 23 May 2000 cover page and the notes which bear the entry on the first page 16.46T, upper case T, Astronautical Guidance, then to the right it says Professor

Wrigley, W R I G L E Y. Below that Dr. Battin. Then appears to say Sterns, S T E R N S - P R O B. Greater.

(Exhibit 4 marked for identification)

Q. Professor Hollister, Exhibit 3 appears to be certain notes from class 16.46 bearing a date of August 1961. Have you ever seen a set of notes for the class 16.46 for the year 1960?

A. I can't recall ever seeing printed notes. They are very often things handed out in class that may be one day or another day and I just can't recall.

Q. Had you received a handout, was it your practice to keep it just as it apparently was your practice to keep certain class notes?

A. Probably not with 100 percent consistency.

Q. Do you know whether or not you have kept any handouts which you received from course 16.46T which you took in the spring of 1960?

A. I cannot remember. It would be possible for me to see if I kept them.

Q. Your cover letter makes reference to notes of, I believe, 21 March and 23 March 1960. I have

opened Exhibit 4 to a page where there are notes, appears to be handwritten entry, 21 March 1960 and underlined. Do you see that, sir?

A. Yes.

Q. Are the notes which come below that entry the notes which you believe that you took in class on March 21, 1960?

A. Yes. These notes are the homework assignment that I am reading.

Q. Were there any notes that you took of what was said during the course of the lecture?

A. I will have to read it here.

(Pause)

A. As it appears as if the next page-and-a-half were all from that date.

Q. You also appear to be looking at a page, sir, that has a reference to 23 March '60 in the middle of the page?

A. Yeah.

Q. I note for the record there are two red checks on the page and those are not checks you put there, correct?

A. That's correct.

Q. I think my question with respect to March 21

was, were those notes of, that you took during the course of the lecture? I think you said at least some of that refers to a homework assignment. Is there an entry for March 21, 1960 made to statements made during the course of the lecture?

A. It would appear to me the remainder of that material was from the lecture.

Q. Are there any notes there which you can identify today which refer to the subject matter of planets as sources of pre-thrusts which could be utilized to project the vehicle from one planet to another without the use of fuel?

A. Well, this statement that it is possible to go to both Venus and Mars in 1.8 years in 1965 or so using about 16,000 feet per second. That would, I think, be what you are describing.

Q. Do you recall -- is that a statement of what Dr. Battin said on that occasion?

A. I don't know how else I would get that information.

Q. Do you, as you sit here today, do you recall precisely what was said during that class?

A. No. It is 40 years ago.

Q. Is it fair to say that the only recollection

you have is that contained in your notes?

A. Yes.

Q. Is it fair to say you do not know whether or not Dr. Battin was reading from notes or some other document during the course of the class on that day?

A. I believe that -- are all pages of these notes here?

MR. HERMES: It is my understanding that's a complete copy of what was produced.

A. If you wanted to give me some time I can see when he first started speaking about the two planet fly-by.

Q. Can you tell me why it was, in May of 2000, you made reference only to the March, to the March 21 and March 23 dates? How did you come to fix on those?

A. I think Dr. Battin was hoping that there would be some evidence that he had done this work at that time. It would appear my notes would verify that, so I gave him that page with the date on it and the information that I had written down.

Q. How does the first reference that you identify, possible to go to both Venus and Mars in 1.8 years, refer to free-fall trajectories using

gravity assist? What's the basis for your belief that that's so?

A. If he was going to go to both Venus and Mars in 1.8 years in 1965 I feel fairly confident that he is talking about two planet fly-by. Is that your question you are asking me to answer?

Q. Yes. How do you come to the conclusion this is relevant to the issues of gravity-assisted trajectories?

A. That statement?

Q. Yes.

A. I think you are asking me to interpret something that happened a very long time ago. When I take notes I write down things I want to remember. I don't know as if I can offer a great deal of detail beyond that.

Q. Other than the words you wrote, you have no recollection of what was, what may have been said on that occasion?

A. Probably be fair to say that.

Q. In fact, you think it is somewhat unfair of me to ask you that question?

A. If you are asking to remember the detail from that period of time ago.

Q. Do you not remember the detail from that time ago?

A. No.

Q. Do you have any memory of Dr. Battin using any time during this course a term such as gravity-assisted trajectories or talking about planets as the source of free thrust?

A. Yes.

Q. On how many occasions?

A. Mostly a few days around this presentation.

Q. Did he discuss during the course of that presentation when it was he first came to understand that planets could be the source of free thrust?

A. I can't recall that.

Q. Did he have occasion to discuss whether or not he had actually performed work in order to determine if there were actual trajectories that could illustrate that?

A. Oh, yes, he had --

MR. SWOPE: Excuse me. Objection to the form of the question. You may answer.

Q. Sorry. You said oh, yes, what, sir?

A. He had calculated the trajectories.

Q. Did you have occasion to review those

calculations at that time?

A. Well, he had given us all of the fundamentals as to how he calculated the trajectories. He showed the process of searching to find the pieces of the trajectory that would match up at the planets that were flown by.

Q. Is that reflected in your notes?

A. It may be.

MR. HERMES: Why don't we take a brief break and if you can identify where the reference to calculations is in your notes. I would appreciate it if you could identify it for me.

(Recess taken)

A. You asked me if there was a recipe how to do this in the notes.

Q. That's a rough paraphrase, yes. Were you able to find something, sir?

A. Yes. Unfortunately these pages aren't numbered.

Q. Can you do it by reference of class date?

A. 21 March '60 on the second page of that where it says round trip. These are the steps that one takes to find a round trip.

Q. You have ten steps identified there, sir?

A. That's right. Basically it is a search process.

Q. Do I take it that those ten steps were Dr. Battin's description of how to do the calculations?

A. Yes.

Q. To determine the multi-planet trajectory?

A. Yes.

Q. Is there anything else there, sir, in that day or any other day?

MR. SWOPE: Objection.

Q. With respect to the calculations of the gravity assisted trajectories?

A. Realize his lecture here is trying to tell you how to do this. From the point of view that's been learned in the class. Then he tells some of the results he has found.

Q. When you say telling how to do this; when you use the word this, what did you mean?

A. How to do the round-trip trajectory where you would like to get a trajectory defined given the start time and the end time. This is the recipe for his calculation.

Q. Was this a trajectory using a gravity assist

at Venus to get to Mars?

A. No. This is the first step is to go between two end-points. The next page he talks about -- then he has to pair two trajectories such that the inbound and outbound velocity magnitude relative to the fly-by planet are equal. This is another search, going through trajectories until those two have the same value.

Q. Why is that important?

A. Because that's -- the physics of the problem is that in flying by the planet, the inbound velocity is a large distance from the planet magnitude is the same as the output velocity magnitude. So that if you found two trajectories that have equal input and output magnitudes, then that would constitute a fly-by providing the trajectory didn't go beneath the surface.

Q. Given your knowledge of the time, that is 1960 and the computer facilities available to scientists like Dr. Battin and yourself, would there need to be multiple iterations of trajectories in order to find these?

A. Oh, yes.

Q. How many?

A. I don't know how to answer that question. The computer runs until it converges. It doesn't tell you how many steps it took.

Q. Would it be unusual that in the first iteration the computer would come up with the ideal trajectory?

A. Well, it is possible that the computer would find a case where these two velocity vectors had equal magnitudes but it couldn't be a physical fly-by because the path required to turn the relative velocity vector would require that the vehicle went beneath the surface.

Q. That's a problem, is it not, because there is no return trajectory if you fly into the surface of the planet?

A. That's right. It is a search process.

MR. SWOPE: NASA has done that once.

MR. HERMES: We have all done that in one way or another.

Q. So that the search for the trajectory that works is a painstaking process and requires many iterations?

A. That's true. Computers do that very well.

Q. But potentially thousands of iterations when

you are talking about something like this?

A. Could be.

Q. So it would be highly unusual on your first try you would come up with the ideal result?

A. Well, you must be careful what you mean by the first try. If you put it into the computer and you tell it to compute until it converges, you might hit it on the first try.

Q. Would that be a surprise to you if that happened?

A. Not if Dr. Battin were doing it.

Q. In doing your paper with your bi-elliptical transfers did you end up having thousands of iterations of trajectories?

A. An awful lot of computing and finding minor errors and correcting it.

Q. I think you said that there was some information concerning the calculations on a page which includes your notes for 23 March '60; is that correct?

A. 23 March '60 is here. What was the question?

Q. I asked you a question about calculations and where the information was. You referred to the

page which included notes from 23 March '60, did it not?

MR. SWOPE: I will object to the form of the question.

A. I don't think I had gotten the question yet.

Q. I asked you to show me where in the notes there were information concerning calculations, correct?

A. Where there were notes -- the red check here that says possible to go to both Venus and Mars in 1.8 years in 1965 or so, with about 16,000 foot per second, and return to earth. That was the result of the calculation.

Q. The notes below that, including your notes for 23 March 1960, did those notes contain information concerning calculations of trajectories?

A. Yes. The one that shows there in a plot are all possible paths to Mars and Venus and then plotted in that space are the contours of constant launch velocity or arrival velocity. Our previous discussion tried to explain why those have to have a constant magnitude, otherwise it is not a physical fly-by. So part of the search could be to plot those contours, then see where the contours

intersect.

Q. My reference to 23 March '60 was simply to identify the page. You have been testifying with respect to certain entries on a page which does include a date 23 March '60; is that correct?

A. Yeah.

Q. For the record I mentioned that because we don't have numbered pages here. If someone wants to know what you are testifying about, there is that reference.

Do you recall any of the people who were in this class with you?

A. Well, you mentioned some of those that were there earlier. The class was organized by Dr. Wrigley, and he invited Battin to come and give a portion of the class, which is the most of these notes (indicating). Dr. Stern was the person that did the grading. Dr. Stern is deceased. What was the fellow's name we just mentioned?

Q. Larry Brock?

A. Larry Brock. Larry may have taken the course the following year.

Q. Can you name anybody else who took the course with you in the spring of 1960?

A. Yes. I think Brad Parkinson took it then. It is difficult because I have trouble remembering people's names. Several of the people I wouldn't be able to say their names. But they went to the moon who were also in the class. Who was the second man that put his foot on the moon?

Q. Buzz Aldrin?

A. Buzz was in the class. Ed Aldrin took it the following year, I believe. Possibly two years later. There were a couple of other guys whose names I am having trouble saying.

Q. I am focusing on 1960.

A. Why is this important?

Q. Because I would like to know the names of the people that were there in 1960 in the class with you.

A. Is that going to benefit you?

Q. It might.

A. That would be very difficult to find an accurate representation of the people that were in that class.

Q. Believe me, sir, I wouldn't waste your time asking the questions if MIT could produce a list of people, but it can't.

A. I don't think you could get that list at this date 40 years ago.

Q. Did you have, when you were at MIT as a graduate student, access to computer facilities?

A. Yes.

Q. Did you have access to an IBM 704 computer?

A. There was an IBM, I don't know what number it was.

Q. Did you ever distinguish between an IBM 650 and an IBM 704 being available?

A. I probably knew the difference then.

Q. You don't recall now?

A. It may say in the thesis what they were computed on. I am not certain.

Q. If it doesn't, you have no memory of the type of machine you used?

A. That's correct.

Q. Incidentally, your notes, Exhibit 4, refer to 16.46T.

A. The T meant it was a temporary course because it hadn't been taught before. I think it is the first year Dr. Battin introduced this material, then subsequent years I think he took it over and it was 100 percent his. The first year he taught it

Dr. Wrigley had a section on general relativity.

Q. Why was there a section on general relativity?

A. Because he was interested in it.

Q. Did you ever read English translations of Dr. Hohmann's work?

A. Well, I must have because it interested me. I can't recall exactly when or what the circumstances were.

Q. Do you recall whether or not it was a NASA technical translation?

A. No, I don't recall that.

Q. When you wrote Exhibit 1 was there some reason why you didn't recognize Dr. Battin's role in gravity assisted trajectories?

A. I referenced his textbook.

Q. The astronautical guidance?

A. Yes. 1964.

Q. That's note what, sir?

A. Sorry?

Q. That's note?

A. Reference number three.

Q. Looks like a three?

A. Yeah.

Q. Did you then think that Dr. Battin had played a role in developing gravity assisted trajectories?

MR. SWOPE: Objection to the form of the question. You may answer.

A. Certainly.

Q. Was there some reason why you didn't mention him by name in the text as opposed to citing to his paper?

MR. SWOPE: Objection to the form of the question.

A. Here at the very first sentence says the use of multiple swing as part of an interplanetary mission was considered as early as 1925 by Hohmann and in '56 by Crocco. After that there were many people that were interested in the subject. Usually I would reference the work if I was aware of it. Not necessarily draw attention to it.

Q. Do you recall -- sorry.

A. Some people object to your putting in a paper information that is available in the literature. Just because it is taking up space. I think in the review of this paper there was a comment that said people know all about that and

they shouldn't have to explain it.

Q. Do you know whether Hohmann ever spoke of the influence of planets as assisting trajectories?

A. I can't recall what is written by Hohmann now.

Q. Can you recall what was written by Crocco?

A. Not now.

MR. HERMES: I have no further questions.

CROSS EXAMINATION

BY MR. SWOPE:

Q. I have one question. In answer to a question that Mr. Hermes asked you about the distinction between the new matter in your thesis and previous work, you refer to the addition of the creative part that you intend as Delta V, what does that mean?

A. Delta V means you have changed the velocity of the vehicle and it is a measure of what is required in the way of fuel in the rocket. So every time there is a thrust the normal assumption is made that relative to the time of the interplanetary trajectory it takes place instantaneously with a magnitude of Delta V meaning the change in the

velocity. It is measured then of propulsive requirements. Most of the efforts are to try to minimize those Delta V's.

Q. Delta means change and V stands for velocity?

A. That's correct.

MR. SWOPE: No further questions. Thank you, sir.

(Whereupon the deposition was concluded at 3:51 p.m.)

C E R T I F I C A T E

I, WALTER M. HOLLISTER, do hereby certify that I have read the foregoing transcript of my testimony, and further certify that said transcript is a true and accurate record of said testimony (with the exception of the following corrections listed below):

Page	Line	Correction
_____	_____	_____
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Sworn to and subscribed under the pains and penalties of perjury this ____ day of _____, 2005.

WALTER M. HOLLISTER

COMMONWEALTH OF MASSACHUSETTS)

)

SUFFOLK, SS.)

I, Katherine A. Tevnan, Registered Professional Reporter, Certified Shorthand Reporter No. 129093 and Notary Public in and for the Commonwealth of Massachusetts, do hereby certify that WALTER M. HOLLISTER, the witness whose deposition is hereinbefore set forth, was duly sworn by me and that such deposition is a true record of the testimony given by the witness.

I further certify that I am neither related to or employed by any of the parties or counsel to this action, nor am I financially interested in the outcome of this action.

In witness whereof, I have hereunto set my hand and seal this 17th day of February, 2005.

Katherine A. Tevnan

Notary Public

My commission expires

March 22, 2007