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10 September 1999

Robert J. Lauson
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233 Wilshire Boulevard
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Dear Mr. Lauson:

In reference to your letter of August 26, 1999 I will address each of your points of concern.

1. As I indicated before, the two figures, which depict the Earth-Venus-Mars-Earth trajectories, labeled Fig. 26 and Fig. 27 on pages 118 and 119 of the Draper Anniversary Volume *Air, Space, and Instruments*, edited by Sidney Lees and published by McGraw-Hill Book Company in 1963, were made from negatives, numbered and recorded in the librarian's log at the MIT Instrumentation Laboratory (now called the Charles Stark Draper Laboratory) for the date 7 February 1961. I understand that prints from these negatives are available upon request from the Draper librarian should that be necessary.

   If you look at the log entries immediately following the entries for my trajectories, you will see that they are for negatives of photographs documenting the Navy Achievement Award to Doctor Draper and his laboratory on February 9, 1961 with negatives consecutively numbered following the numbers assigned to my negatives.* The US Navy can, of course, confirm this event unless you choose to assume that they too might be part of a grand conspiracy to steal the glory for the gravity propulsion idea.

2. You remarked that real scientific inventions are documented by published papers. Yet Dr. Minovitch's "paper" of August 23, 1961 was not a journal publication but a JPL Technical Memorandum titled "The Method for Determining Free-Fall Reconnaissance Trajectories."

   My paper on the same topic, with a remarkably similar title, was published in the *Journal of the Aero-Space Sciences* in September of 1959 almost two years earlier. Called "The Determination of Round-Trip Planetary Reconnaissance Trajectories," it was presented in New York on January 28, 1959 at the annual meeting of the Institute of the Aeronautical Sciences. Two well-known (to your client) engineers,

* Your use of terms like "copies of entries alleged to come from your university's instrumentation library (of questionable authenticity)" and "suspicious entries in library logs" is an insult to the integrity of MIT (whose name you have scrupulously avoided using in your latest accusations) but the implication is clear. Do you seriously believe that MIT would falsify its archival records so that I could claim the meaningless title of "Inventor of Gravity-Assist Trajectories"?

Rollin Gillespie and Stan Ross, were in the audience and had carried a preprint back home to their associate John Breakwell at the Lockheed Missiles and Space Division. They, too, had been grappling with the trajectory problem and (according to them) this was the "breakthrough" they needed.

Both my 1959 paper and Minovitch's 1961 TM address the same problem in essentially the same way. Both use what are called "pieced-conic" approximations and both employ vector analysis. Near the end of the TM on page 38, Minovitch suggests that it might "be required to visit more than one planet before returning to its launch planet." This requires but a small change in both methods. In my 1959 paper on page 562 it is remarked that the return to Earth calculations are the same as for Earth to Mars. It doesn't take a great deal of imagination to see that the trajectory back to Earth could just as easily be a trajectory to another planet and then another planet, etc. for whatever mission one would like. Minovitch does include an Appendix in which he outlines a method of successive approximations to a numerical solution of the restricted three-body problem. In Section 6.6 of my book *Astronautical Guidance*, the same objective is accomplished using perturbation matrices.

The method described in my 1959 paper became the basis of the major orbit-determination programs of the Jet Propulsion Laboratory for its series of unmanned interplanetary probes, and of the Navy and Air Force for targeting ballistic missiles. Indeed, in the early sixties, JPL used this technique to generate an enormous set of volumes in which were tabulated daily launch conditions for Venus and Mars missions extending many years into the future. (I recall that every month or so I would receive from JPL a volume filled with these trajectory data. In the introduction to each volume, my method was described in detail with appropriate credit to me.)

This was the tool I used to generate all of the trajectories which were described in the Draper Anniversary volume. It was used for the Earth-Venus-Mars-Earth calculations in January of 1961!! And it was the method which *could have been used* for all the multiple fly-by calculations that Minovitch claims to have made at JPL.

3. Walter Hollister appears to loom large in the mind of your client. First, of all he was not my thesis student. He took my course, which was introduced at MIT as a temporary subject in the spring of 1960, and kept his class notes. These notes establish that on March 21, 1960, when I was describing round-trip trajectory calculations to the class, Hollister recorded "Possible to go to both Venus & Mars in 1.8 years in 1965 or so* with about 16,000 ft/sec & return to earth." He remembered that I referred to this as "celestial billiards." Besides Prof. Hollister, there were 22 others in the class including Dr. James S. Miller, Dr. Robert G. Stern and George P. Edmonds.

The next spring (1961) I had a class of 19 students including Buzz Aldrin, the second man to walk on the moon, Stanford Professor Bradford W. Parkinson and Dr. Larry D. Brock. They heard the story of the multiple fly-by orbit Earth to Venus to

* This is in good agreement with the trajectory, whose launch date is Feb. 6, 1966, a launch velocity of 16,500 fps and a total flight time of 1.8600 years, which is Fig. 27 in the Draper Anniversary Volume and recorded in the MIT archival logs.

Mars to Earth. They saw for the first time the beautiful colored slides of these orbits which were made in February of 1961 for my class use and they are the ones which are recorded in the log books of the Charles Stark Draper Laboratory.

The next spring there were 40 more students, including Dave Scott, who commanded Apollo 15, MIT Professor John J. Deyst, Jr., Dr. Steven J. Madden, Jr. and Colonel Albert E. Preyss, so that over 80 students had been witnesses to my discovery of the Earth-Venus-Mars-Earth orbits before the summer of 1962.

I was not a member of Hollister's thesis committee. He acknowledged me in the Introduction of his thesis because he had taken my course and referenced my book *Astronautical Guidance* which contained all the details of planetary fly-by orbits from my 1959 paper as well as the two Earth-Venus-Mars-Earth trajectories from the Draper Anniversary Volume.

It is absolutely ridiculous to assert, as you did in your second footnote, that Walt Hollister claimed in his thesis to have invented gravity-assist trajectories. He did no such thing and he readily agrees that he never claimed such credit. He used that idea together with the concept of the bi-elliptical transfer (which, he agrees, he also did not invent) to design "The Mission for a Manned Expedition to Mars" as his thesis.*

4. In your letter, you ask the question: "Why did your fellow faculty member Hollister in 1970 publish a paper giving Dr. Minovitch credit for originating gravity-assist trajectories?" As it has turned out, that was really a very interesting question.

   I learned that when Prof. Hollister submitted his manuscript to the AIAA for publication, the reference to Minovitch was simply "Minovitch (ref. the 1963 JPL TR) described a round-trip mission leaving and arriving Earth with six intermediate flybys (listed in the order they occur) at Venus, Mars, Earth, Mars, Earth, and Venus."

   As is the custom, the paper was sent to anonymous reviewers for their comments and recommendations. One of the reviews was two and a half typewritten pages single spaced. There were some constructive comments as to substance but more than a page was a strong criticism of "the authors' introduction concerning the historical development of Swingby techniques." Then, after a detailed critique of Hohmann and Crocco: "The missing ingredient was precisely these 'annoying' planetary gravitational perturbations. It was Minovitch (ref. 1961 JPL TM) who first recognized the fundamental role planetary perturbations should play in interplanetary trajectory design and how they could be utilized to 'propel' a space vehicle anywhere in the solar system by 'bouncing' it off the gravitational spheres of influence of various planets in a controlled manner, essentially 'free-of-charge,' with out any appreciable rocket thrust after injection. The authors should get a copy of this paper by writing the library of the Jet Propulsion Laboratory in Pasadena, California or to the AIAA. It was his

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* You make the absurd statement in your letter that "The existence of Hollister's PhD dissertation shows that you (meaning me) did not make the invention (of gravity-assist trajectories).. Clearly, the authenticity of this dissertation far surpasses the authenticity of any log from the library of your Instrumentation Laboratory." I can't even imagine a more convoluted illogical deduction!!

concept of viewing planets as free and virtually unlimited vehicle thrust sources which underlies the so called 'Swingby' techniques."

The review closed with the remarks "I have studied this paper in considerable detail and found it to be weak on the above points. Although the paper is generally high in new technical content, there is room for considerable improvement. I therefore recommend that this paper be returned to the authors for revision and resubmitted for consideration at a later date."

Being a young assistant professor at the time, Hollister felt that he must include those extra two Minovitch references and the extra background on Minovitch as a precondition for publication.

Now, in this light, lets look at what Walt Hollister said in his 1970 paper:

> "The use of multiple swingby as part of an interplanetary mission was considered as early as 1925 by Hohmann (ref. 1 in the paper) and in 1956 by Crocco (ref. 2) ... It was Minovitch (ref. 6 is the JPL TM) who first recognized the fundamental role which the planetary flyby can play in trajectory design. He saw the planets as sources of free thrust which could be utilized to project a vehicle from one planet to another without the use of fuel ..."

Finally, am I still missing something? Where does Hollister say that Minovitch "originated" gravity-assist trajectories? It appears that your client has a tendency to see things that he wants to see that are really not there.

5. You ask another rather strange question: "In 1990 why did you tell William Kosmann in a documented interview regarding your role in the development of gravity-assist trajectories that you discovered Earth-Venus-Mars-Earth gravity-assist trajectories in 1956?" I did not tell him that. In 1956, I was a member of the Operations Research Group of Arthur D. Little, Inc. and consulting for industries like Michigan Bell Telephone, Philco and Caterpillar Tractor none of whom had any interest in that subject. I did not begin my research in celestial mechanics until I returned to MIT early in 1958 following the launch of the Russian Sputnik in October of 1957*. But, why would you even care?

6. There is no inconsistency between our successful efforts to meet the original deadline for Draper's sixtieth birthday on October 2, 1961 and the fact that the commemorative book was not published until 1963. Hal Laning and I did, indeed, meet our commitments and we assume no responsibility for the late publication of the Draper Anniversary Volume.

   It does not take a rocket scientist to infer what must have happened. Some of the other authors were not as conscientious. Their contributions were late—hence, the later dated references to which you refer.

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* "Space Guidance Evolution—A Personal Narrative" in the Journal of Guidance, Control, and Dynamics for March-April, 1982.

7. Finally, I ask you to consider my own opinion of what I did in January of 1961 as stated in the Draper volume. I quote from the last paragraph of our chapter: "It is sad to report that these double reconnaissance trajectories are little more than astronomical 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 a 6-year postponement in the mission."

   You asked why I never "publicly claimed credit for this revolutionary and fundamentally important discovery until 1994." The answer is simple—I had failed to recognize its potential for future space missions.

8. There is an article in the August 1999 issue of the magazine *Astronomy* titled "The Spacecraft's got Swing" written by James Oberg. I found the following paragraph to be quite enlightening:

   > "In the 1920's, the Russian physicist Fridrikh Tsander described the maneuver (the planetary flyby), and during the 1960's German engineer Krafft Ehricke, who worked on the V2 rockets with Wernher Von Braun during World II, had outlined the mechanics of gravity assists in his book *Space Flight*. By the dawn of the Space Age, swingbys were fairly well known. In California, at NASA's Jet Propulsion Laboratory, graduate student Mike Minovitch devised a computer program that analyzed the possibility of using gravity assists on all possible missions. And at the same time and place, graduate student Gary Flandro was also working on a swingby plan. His trajectory proposed using the gravity of four planets to fling a spacecraft from one world to the next. But physicists and engineers at NASA headquarters remained skeptical about the technique. 'They were adamant this wouldn't work,' says Flandro, who now works as a professor at the University of Tennessee Space Institute."

   Perhaps you can explain why James Oberg did not refer to Dr. Minovitch as the inventor of gravity assist trajectories rather than as a computer programmer analyzing possible missions.

   Perhaps you should contact Professor Gary Flandro. He teaches Astrodyamics at the University of Tennessee and uses my book as the text. He is very familiar with my work and has known Michael Minovitch personally and his contributions for almost forty years. He can be reached at:

   Professor Gary A. Flandro
   625 Overlook Circle
   Tullahoma, TN 37388
   Home telephone: 931-454-1093
   Office telephone: 931-393-7217

In conclusion, let me state that I do not and have never claimed the "inventorship" of Gravity-Assist Trajectories. I made an early contribution to the field as I have explained and which is well documented. Furthermore, I have a highly respected reputation in the

the field of astrodynamics, guidance and control for which I am very proud. I have received numerous honors and awards. I am a member of the National Academy of Engineering and an Honorary Fellow of the American Institute of Aeronautics and Astronautics (their highest grade of membership awarded to no more than three individuals per year). In May of this year I received an Honorary Doctor of Science degree from Texas A & M University. The attempt by you and your client to sully my reputation with frivolous accusations will succeed only in irreparable damage to your client's reputation—not mine. However, if this harassment continues, I will have no other choice than to seek legal redress against you and your client.

Very truly yours,

Richard H. Battin

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