FORTUNE EIGHT
Aerospace Industries, Inc.
International Technical Services

Original Lecture: 2002 April 24

MEMORANDUM

To: CMA Class
From: Chauncey Uphoff
Subject: Class Notes for Lecture #14

In Lecture #14, I tried to clean up most of my promises made during the lecture series. I started with the following outline (something rare for me, but necessary because we were almost finished with the course). And I wanted to get this stuff cleaned up before you all had to suffer the slings and arrows of outrageous final exams. I always hated those; I never learned much until I went back to find out what I had done wrong. That's why I graduated "Thank Laudie," instead of *Magna cum Laude*. This play on Latin words is from my good friend and colleague, James P. Johnson. Here's the outline.

1. Blair Thompson's handout for Lecture #9 when I was on unavoidable travel. I showed how to fix Blair's equations if you're on a Mac™. Later, I found that what I showed you doesn't work with the latest versions of MicroSoft™ WORD (for Mac) unless you're part of the priesthood and know how to fix things. Don't worry about it; it will change within a few months. Then, your "knowledge" will be obsolete.

2. Next, I discussed "Resonance hopping" and related that concept to what you're doing in your Lab project (Earth-Venus-Earth-Earth) gravity assist to a Jupiter swingby or orbiter. Resonance hopping is an important concept discussed in the paper "Orbit Design Concepts for Jupiter Orbiter Missions," (see my résumé).

3. Then I gave the answers to some of the word problems that was part of the unrequired homework. (See IBeforeE.doc in bonus handouts.) The problem was to make sense out of the following by adding punctuation and capitalization only:

Smith where Jones had had had had had had had had had the editors approval

The other word problem was to identify what color hat is being worn by the second "he" below.

He whose hat, he whose hat was red wore, had a green hat.
The answer to the first problem is:
Smith, where Jones had had "had," had "had had." "Had had" had the editor's approval. (Or one can replace the period with a semi-colon and not capitalize the next "had.")

The answer to the second problem is green.

These problems are good ones to work on because they help increase communication between the right and left brain.

4. Next was a short description of Earth-frozen lunar orbits, those whose argument of pericenter is "frozen" by the long-periodic Earth perturbations on the lunar orbit. I mentioned that these frozen nearly polar orbits are stable for long periods of time (several tens of years) and that the frozen values for argument of pericenter and eccentricity tend to move around because of the motion of the Earth-moon plane due to the solar perturbations on the moon's orbit.

I'm sure I mentioned C.B. Boff's law of lunar satellites. "A lunar satellite will crash into the moon as soon as it can." But, if we're clever and balance the perturbations against each other, we can create orbits that stay where we want them for long periods of time. See my paper "Stabilizing Influence of Earth Perturbations on Polar Lunar Orbiters." I also mentioned that I thought this was my idea but, when I started to write it up for a journal, I discovered a paper by Kozai (c. 1961) that was familiar to me. Kozai was there long before I was. I realized that I had seen his paper and stopped writing my journal article. It was not original to me even though

I thought it was. Sometimes we forget our inputs and we must be careful not to steal from others, even if it is a "sincere" theft.

5. Next was a short discussion of how luni-solar perturbations interact with the oblateness perturbations for a GEO (Geosynchronous Earth Orbit). These perturbations couple to cause a change in inclination that would not occur with either perturbation acting alone. I described what I called strong-coupling in my 1969 paper on "The Long-term Motion of Artificial Planetary Satellites." (Published as a pre-print in 1971). The GEO (24 hour, near-circular) orbits are right on the strong coupling curve.

6. As I was trying to cover a bunch of stuff I had left out during earlier lectures, I quickly moved on to showing Keith Speckman's graphical representation of the mean anomaly. This is posted on the web-site but I had a few things to say about it. I had a great plan to relate the chord length of a larger circle to the arc length FM of Keith's picture. Frank Janssens pointed out that I was trying to "square the circle" and I immediately gave up on this because I know that it can't be done with ruler and compass. That would require the "ruler and compass" representation of the cosine of a cosine. As that is a transcendental function, it is "nye voz mozhno" (not possible for a man, only for a god).

I reiterated my admonition to all students that they should not finish my course without being able to pronounce the word "Lightning" in Russian. The word is almost universally mispronounced by Americans (especially Air Force types) as "Molneyeya" with the emphasis on the "eye" and the o pronounced as in mole. This is one of the most grateing expressions to the Russian ear in the history of the Russian language. The proper pronunciation is Mo (almost as in more) lnya, with the emphasis on the first syllable. Learn it by heart and mind; it will stand you in good stead with our Russian colleagues. But never correct a USAF Bird Colonel if he or she mispronounces it. That would be more politically incorrect than I am. I am grateful to moi dorogoi, Val Lutchenkov, for the proper pronunciation.

7. Finally, I launched into a diatribe on the advantages of solar sailing and showed figures from my paper "Very Fast Solar Sails." I showed the "Cassegrain Sail" idea that I thought was original. Dr. Forward invented the same idea and published it as a mechanism for suspending a light-sail above the GSO latitude. Dr. Forward had found, in Elena Polyakhova's book, a reference to Skoptsov's invention of the same idea in the early 1970s. So Dr. Forward and I were a little bit late with this one. But we were both independent of Skoptsov and of each other. Dr. Forward and I thought of this idea independently of ourselves and of Skoptsov. As a great scientist once said "If two do the same, it's not the same."

   I showed a number of ideas that take advantage of the radiation pressure for several kinds of payloads. The most interesting (to me) are the ones where the solar sail is the payload. I suggested sending a huge number of tiny needles (of length 12.7 cm) so that they would reflect the major solar output frequency back to the Earth. In that way, the "cloud" of needles could be tracked well beyond the heliopause.

   I cannot imagine that I stopped talking here, but I can't remember what I talked about. Check out the "Very Fast Solar Sails" paper on the web-site if you have time this summer. Jason, Rodney, and I have decided to leave the web-site up until next fall so you can all go back and figure out what you did right or wrong. That was the best part of my education – the second best part of my life.

   By now, we have assigned grades for the course and have turned them into the powers that be. Nobody failed. I'll discuss what (almost) everyone did wrong in the homework assignments in the some of the assignments. In the next lecture notes (#15), I shall explain what most of you did wrong. Almost all of you did the labs and project very well. I wanted to give some of you an A^+ but I was not allowed to do so. The next lecture notes will contain the solution to the course question; only one of you got the answer right. That was a surprise to me.

Best regards,
Chauncey Uphoff 2002 May 18