ROSE-HULMAN
INSTITUTE OF TECHNOLOGY

DEPARTMENT OF PHYSICS AND OPTICAL ENGINEERING

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To: Julia Williams, Executive Director, Institutional Research, Planning and Assessment

From: Richard Ditteon

Re: Tablet PC Proposal for Improvement of PH322 Celestial Mechanics

I have been teaching PH322 Celestial Mechanics at Rose each spring quarter for the last three years. The course is a very rigorous upper division physics elective. Despite its nature, the course has become quite popular with students (average enrollment of 23). The majority of students in the class are mechanical engineers who take the course as part of the aerospace concentration. A few students take the course as part of the astronomy area minor. The subject matter of the course involves only a few very basic concepts: Newton's laws of motion and the Universal Law of Gravity. But applying these rather straightforward concepts to the motion of earth orbiting satellites and planetary motions involves some very complex calculations. As I warn the students at the beginning of class, "This IS rocket science."

Rose students are very good at mimicry. Once I outline the steps involved in a particular type of calculation, most students can follow the recipe and get reasonable results, no matter how lengthy or involved are the calculation. But, I think that a Rose-Hulman education should go beyond rote application of a prescription. I want the students in this course to be able to apply the formulae to problems they have not previously encountered. To accomplish this goal, I think it is essential to show the students how the formulae are derived. I spend a lot of lecture time going through the derivations of the equations that we use. The hope is that they will understand the physics behind the formulae.

Derivation lectures are terribly boring no matter how lively the instructor. It is extremely easy for students to zone out. So, while doing a derivation I try to stop frequently and ask what the next step should be in an attempt to engage the class. Typically, however, only one or two students respond. Of course, these students are usually the brightest students. The students who really need to be learning generally just sit passively.

Last year I started using "worksheets" in this class. At the beginning of the lecture I pass out a handout with typed comments and places to add steps from the derivation. Then, as I lecture, the students can fill in the worksheet as we go through the derivation. The worksheets provide the students with carefully drawn figures, clearly defined variables, and (if they fill in

the worksheet) a compete derivation. The students have given me feedback that they like the worksheets better than just their own notes.

From what I've seen of the Tablet PC's and the DyKnow software I could take the concept of the "worksheet" as a note taking aid a huge step forward. What I would like to try would be to do the derivation on the Tablet PC (viewed on a projection screen). Then, when the class is over, the entire class could download the entire derivation easily. But, if this was all I wanted to do, it would actually be a step backward, because it would allow the students to be even more passive in class.

To fully engage the entire class what I would like to do is to poll the class electronically about what the next step of a derivation should be. I'm not exactly sure how this would work, but my intention would be to use the summer to become familiar with the Tablet PC and DyKnow software and to try out various ways to structure lectures. For example, it may be possible to simply ask open ended questions like, "What would you get if you combined this equation with that equation?" The students would submit their results and I would view what they submitted. I could quickly see if they aren't following along or if they really do understand the concepts.

I suspect that open ended questions will take too long. It may be better to give multiple choice or fill in the blank type questions where appropriate. The majority of the summer would be spent working out these kinds of details. Also, I suspect that an interactive approach will use up more lecture time. I will have to give considerable thought to what material might be omitted or presented in alternate ways.

As I mentioned earlier, I also work out extensive example problems in class. I would like to experiment with making the example problems interactive also. Working example problems on the Tablet PC will have the same problems that giving interactive lectures would have. The problems need to be structured so that they can be completed in a reasonable time and still engage the student. I would also like to try recording worked examples with voice overs and pop up bubbles so that the students could view the worked examples on their own time. If this is successful it would free up lecture time to cover more material in greater depth.