

A JUMP AND A JERK – Teaching Notes STAR Leadership Program

Objectives

Learners will be able to:

1. Utilize mathematical modeling to respond to a real world scenario.
2. Write a letter to a “client” (non-specialist) to communicate the findings.

Materials

Letter from client to students (see below) .

Preparation Prior to Students Entering Room

1. Make copies of client letter.

Part 1 – Activity

You have been contracted by S.O.R. Tosane, Inc. to do some work on parachute jumps. Here is how you should proceed.

- Use mathematical modeling with one or more ODEs to respond to the client's requests. In order to solve ODEs, you must use one of the numerical approximation methods we have studied. You should use Excel in order to solve.
- Write your client a letter explaining your findings. Be sure to keep in mind the fact that your audience is someone who knows very little mathematics. Include all relevant information and calculations in your response. However, you may find it is more appropriate to include some calculations in an appendix. You also need to submit your Excel files.

Part 2 – Activity Debrief

Once you have completed the project, please reflect on your experience working in your group. Each person should write their own reflection paper. It should be at least one page (typed) and should address the following questions.

1. How well did your group work cooperatively in preparing the final product for this assignment?
2. How effectively (or ineffectively) did your group communicate?
3. How did you distribute the lab work among group members? Was it effective? Why or why not?
4. Looking back over the whole project, what was the most important thing you learned? What skills did it help you to develop and how can you see using them in life after college?
5. How could I structure this assignment next year that would help next year's class have a better or deeper learning experience?

Client Letter:

Dear Differential Equations Students,

As you may know, S.O.R. Tosane, Inc. is a newly founded company devoted to giving its well-paying clients the proverbial "ride of their lives," be it through scaling Everest or running through a crowded auditorium screaming "fire." A significant number of our customers are concerned with throwing themselves to the four-winds, so to speak --- or at least, with throwing themselves out of planes, usually after having put on parachutes. In these endeavors we are as always most willing to help, though unfortunately it then becomes incumbent on us to investigate the safety of said clients. It is for this reason that we are contacting you.

Our well-heeled clients will be jumping from a military surplus cargo plane that we have purchased for this purpose. The plane will be flying at an altitude of around 10,000 feet, at a speed of approximately 175 mph, when they jump from the plane. We expect the terminal (no pun intended) velocity in free-fall to be about 120 mph. All of our clients will be equipped with a main and reserve parachute; the main chute should be deployed early enough that if it fails they will be able to then deploy the reserve chute in time to avoid a messy end. We expect an average client to take on the order of 10 seconds to deploy the reserve chute if the main chute fails to deploy. The main chute takes around 3.5 seconds to fully deploy, while the reserve will deploy in only 1.5 seconds. We estimate that the terminal velocity with the main parachute is 15 feet/sec and the terminal velocity with the reserve parachute is 17.5 feet/sec. Our adventurous clients would like to achieve these speeds when they land.

The first information that we need from you is when we should instruct our clients to deploy their main parachute so as to maintain a modicum of safety while catering to their daring bravado (our clients would like to spend as much time without a parachute as possible). It may be useful to note that our physical measurements department reports that air resistance on a falling body is proportional to the square of a person's velocity when no parachute is in use, and proportional to the velocity when falling with a parachute.

A secondary consideration is the stress that will be introduced on these eager clients in the course of their adventure. The "opening shock" or "jerk," (which, contrary to popular belief, refers not to the parachuter but to the effect to which they are subject --- a subtle distinction lost on many), is defined to be the time derivative of the acceleration of the parachuter. We should like the force associated with the jerk ("jerk force") to be less than about 3 G/s over the time in which the parachute opens. (Here G is the force exerted by gravity on a body --- thus for the force on the body to be less than 3 G, the acceleration must be less than 3 g.) You should therefore also indicate whether this is the case for our currently expected jump. We would also be interested in knowing if the "jerk force" is less than 1.5 G/s, so that we may allow older clients to be, if we may put it indelicately, jerked around.

Needless to say, the list of clients desiring to throw themselves from our plane is a long one. We therefore need your report on this matter by Friday, April 28, in order to prepare for the summer tourism boom. To facilitate this, we have arranged with a great friend and patron --- this being none other than your peerless instructor --- to answer any questions you might have in the process of working on this problem. We look forward to hearing from you.

Sincerely,

Sired M. N. Dehilary

President, S.O.R. Tosane, Inc.