Building a One-Dimensional Simulation of a Rocket: Requirements

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Chapter 1

Overview

1.1 Purpose

Research shows that hands-on methods are more effective at teaching calculus principles than traditional, lecture-based approaches. We believe that the use of a computer simulation of a rockets flight is an effective tool to teach a calculus lesson.

A computer simulation affords students the opportunity to see how one change to a functions input can effect its output and its derivatives. We hypothesize that using a simulation will increase students conceptual knowledge of the derivative, and it will provide them with the practice necessary for mastering the manipulation of functions.

I intend to create a simulation of the launch of a model rocket, for use in the teaching of a High School Calculus lesson. The simulation will be browser-based for portability, and will be written primarily in PHP and JavaScript. The simulation will produce accurate data, as well as visual representations of the data for students to analyze.
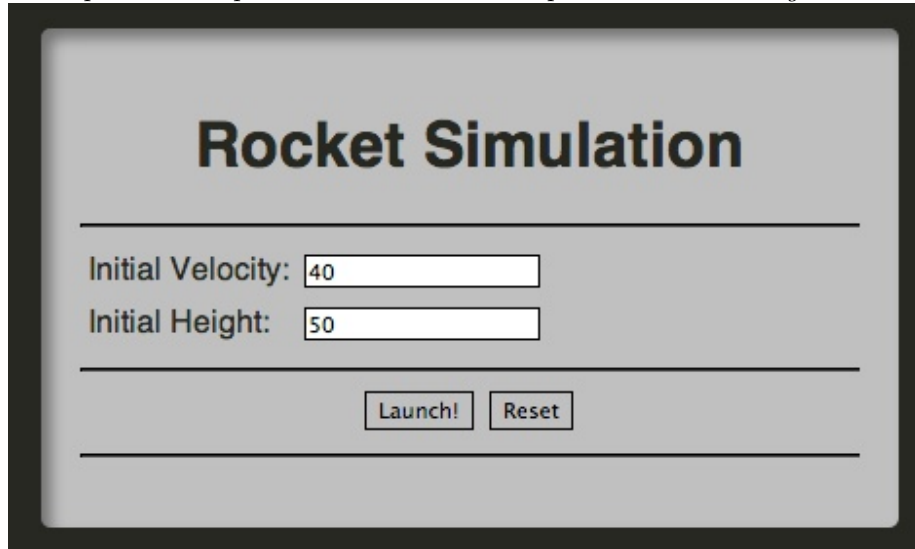
Chapter 2

Overall Description

2.1   Production Perspective

The simulation will be web-based to allow it to be as universal as possible. The more effective it is, the more portable it will be as a teaching tool. The back end will be built primarily in PHP and JavaScript, while the front end will be built in HTML and CSS. PHP offers a powerful language for the generation of the data, while JavaScript provides tools for making the graphical output very interactive. I chose to use these languages over applet platforms, such as Flash and Java, because they allow for the product to be more portable. It is our goal that the software will be as effective and useful on mobile devices, such as tablets and smart-phones, as it will be on a traditional computer. Many such devices do not support Flash or Java, while JavaScript is much more widely supported. The software must take input from the user and generate output in CSV (Comma Separated Values, a common format for statistical analysis), which will be downloadable, and also in the form of a graph of velocity v. time and height v. time so that users may visualize the data.

2.2   Product Functions

The product will present the user with an input interface. *See Figure 2.1*

Figure 2.1: A prototype of the input panel.

It will present a data-representation of a flight based on the user's input and make this data accessible within the application and by download. *See Figure 2.2*
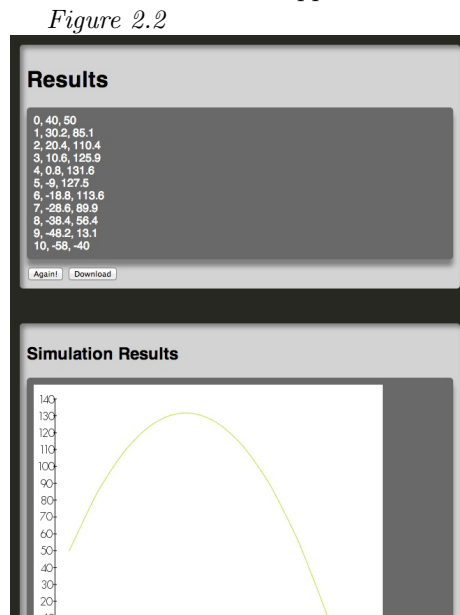

Figure 2.2: A prototype of the output panel.

It will also present the user with a visual representation of the data in the form of line graphs.

2.3 Constraints and Assumptions

2.3.1 Constraints

The simulation will only represent one-dimensional motion. It will take into account the height the rocket achieves, but will not consider any lateral distance. It will run inside of a web browser, rather than being a native application. The application, being built in PHP, will require a web-server to run. PHP is a server-side language.

2.3.2 Assumptions

The user must have an Internet-connected device or take it upon him/herself to host it locally. It will require a web-server to run. The application will most likely be nimble enough to run on a dial-up connection without incidence, but broadband connections are so common that we will build it with the assumption that the user has access to one and will not constrain ourselves to making it comfortable for a dial-up connection.

2.4 Timeline

- Simulation Guts......................................September 25, 2012
- Basic Interface.....................................October 10, 2012
- Enter Alpha..November 6, 2012
- Requirement Doc Draft................................By January 31, 2013
- Spec Docs Finished...................................By February 14, 2013
- Graphs Implemented...................................By February 16, 2013
- Graphs Polished By February 24, 2013
  Scaling, Hiding, etc.
- Minor features implemented (Data validation, etc.)....By March 2, 2013
- Enter Beta...By March 4, 2013
  This phase will constitute user testing.
- Ship...By March 21, 2013

Chapter 3

Requirements

- Must produce accurate data
  Several sample data sets will be run by hand to ensure that the simulation is achieving this.

- Export data as CSV via web interface

- Must produce graph of rocket's velocity height

  - Graph must be properly labeled and scaled
  - User must be able to view velocity and height both separately and together
    This will be done by check-boxes or radio buttons; client has no preference.

- Must work on any Internet connected device with a JavaScript-enabled, modern browser
  We define "Modern Browser" to mean released after 1/1/2011 and supporting HTML5 and CSS3.

- Must list range of example input values for Initial Height and Initial Velocity
  As per client's request, input will be text boxes, rather than drop-down boxes.
  Data validation will be done, most likely, through JavaScript

- System Portability will be ensured by the fact that the software is web-based and built in standard technologies (i.e., no plug-ins required).

Chapter 4

Future Features

- Client would like a loading screen with a graphic of a rocket flying in an arc.