

Marsh White Award Report
Eastern Michigan University Winter 2013

At Eastern Michigan University, there are several skills physics majors will develop while earning their degree. Some of these skills include: soldering, reading electronic diagrams, wiring electronic circuits, computer programming, using microcontrollers to control a system, and to construct and build an originally designed structure that follows the laws of physics as predicted during design. We wanted to design an activity to get students involved in extracurricular physics activities earlier because the majority of our Society of Physics Students organization is graduating seniors. We also wanted this activity to include some of the skills they already were developing along with skills they would learn in the coming years. For this reason the activity was open to Eastern Michigan students taking the second level sophomore physics course on introductory light and electricity. The proposed idea was to design a roller coaster track with a team that a marble could continuously travel on without any human interaction. The track design would incorporate the student's current knowledge of introductory mechanics. To raise the marble up the large hill, students were given a micro controller, motor, and motor driver. The goal of this project was for them to learn how to program the microcontroller enough to control the motor and to integrate everything together in a system.

We held a seminar to teach students how to program and work with the microcontroller. We also provided documentation and examples of how a motor would work. The students were given a budget of \$30.00 for other supplies that they would supply themselves. This was to keep the project fair between teams. After this, we let the students out on their own to complete the

project. We offered them help when they needed but we wanted them to work on problem solving and trial and error skills.

The most common problem for students was getting the motor to function properly. With a little help from our friendly seniors working in the Physics Reading Room, a popular place for physics students to study and get free tutoring, the problem was solved quickly. There were a total of three groups who began participating at the beginning of this activity. Each group was made up of two or three students. Two groups were unable to finish. One group became overwhelmed with course work and became frustrated with understanding the microcontroller and motor system while the other group had technical difficulties only. This group blew their motor and microcontroller because they used improper resistance in their circuit causing an overload of current to pass through both devices. This was near the end of the activity and they decided to give up and focus on finals. The final group was able to successfully complete the roller coaster and pictures are attached at the end of this report. This roller coaster was fully functional up to the night before the final showing of the projects. The motor burned out while changing the counter weight on the pulley which allowed the marble elevator to work continuously. We verified the roller coaster worked within the guidelines.

Despite having a group complete the project, more people dropped out than we would have liked. Now that we have done this project once, we know what we would like to do differently in the future to have a higher completion rate. The first thing that gave students problems was the time frame. We did not have the money as early as we would have preferred to begin this so we started it much later than originally planned. Students had about a month and a half to do the whole project and unfortunately that time period was during final projects and exams. When we bought the supplies for this, we bought enough of everything for ten total

groups and everything we bought should be reusable for future use. Now that we have the supplies, we might try to begin the project with students during their first semester of sophomore physics in introductory mechanics during the fall semester. During this semester, they can design and construct the roller coaster so the marble makes its way around the track when dropped at the top by hand. Part of the activity is also to predict maximum speed and forces at specific locations on the track. This could all be done during the mechanics semester. At the start of winter semester and their electricity class, they could be introduced to circuits in class and learn how to program the microcontrollers at a seminar held by upper level students. They could spend time working on a mechanism to elevate the marble to the top of the first hill. We would also like to have meetings with the students every couple of weeks to trouble shoot problems, discuss progress, and so students could get insight from other groups. With the extra support and longer time period to work on this project, we expect a higher completion rate and higher quality roller coasters.

The project will not always be restricted to roller coasters in the future. The common theme for future projects will be the Arduino microcontrollers. This is an important device we use in our senior capstone class and it would be helpful for students to be familiar with them coming into the class. Most students will take this class during their third or fourth year at Eastern Michigan.

We think that we are set up to carry out this or a similar project for many years to come. Getting students interested in our Society of Physics Students Chapter early will help them to become familiar with older students and the department overall which could help them be successful during their time at Eastern Michigan University.

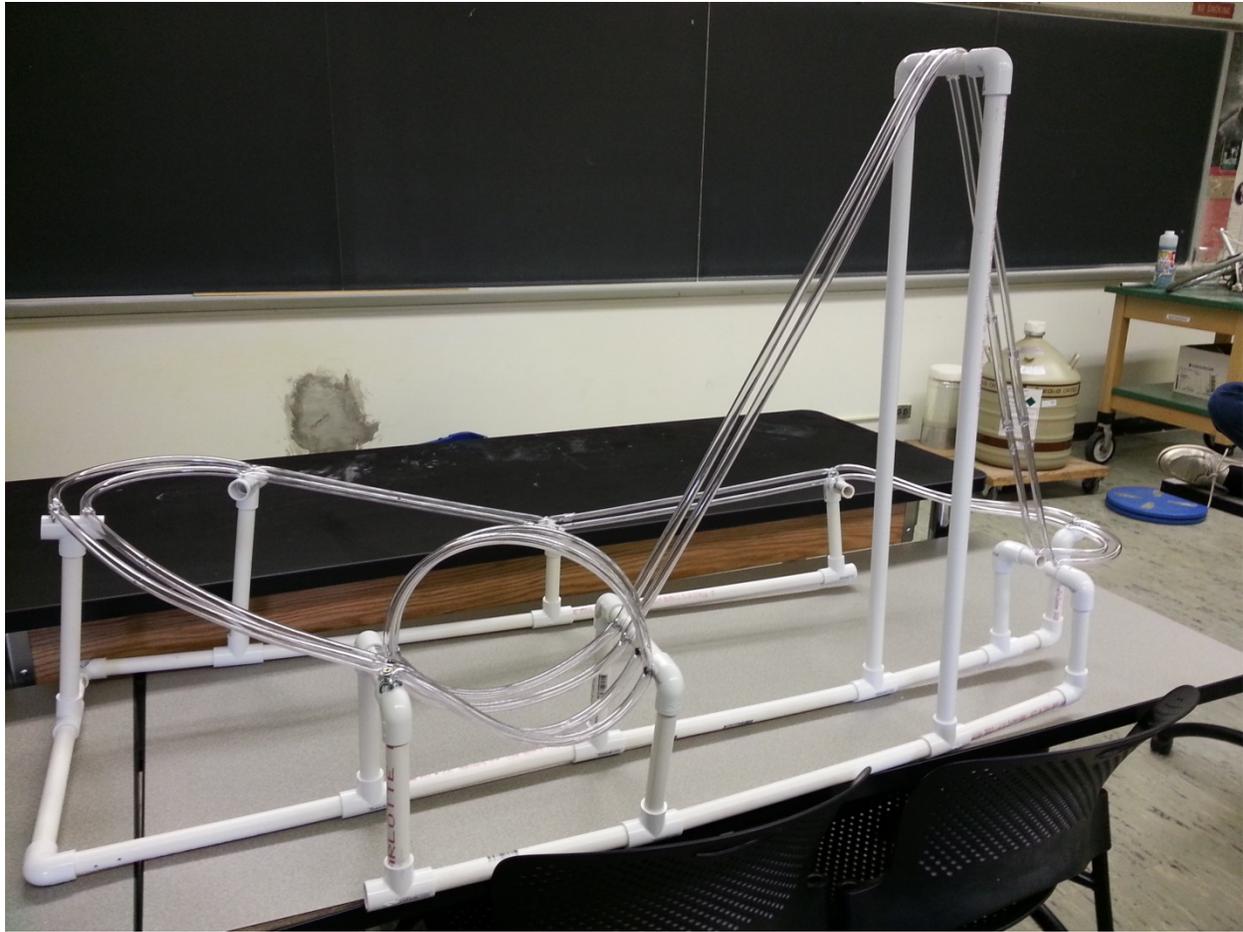
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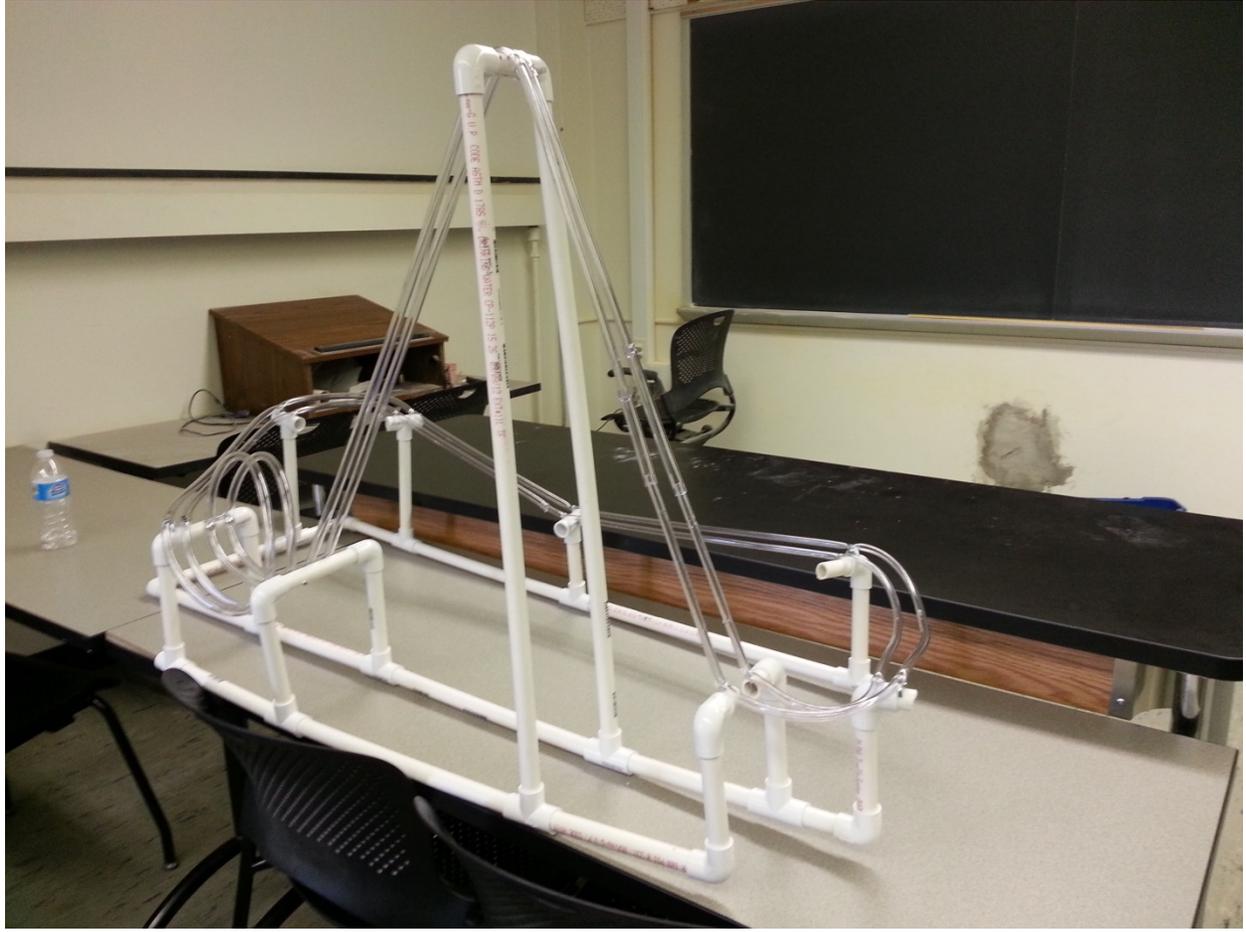
| Item | Quantity | Total Cost |
|--------------------------------|-----------------|-------------------|
| Arduino Nano Microcontrollers* | 10 | \$250.00 |
| Stepper Motor | 10 | \$149.50 |
| Stepper Motor Driver | 10 | \$149.50 |
| <hr/> | | \$549.00 |

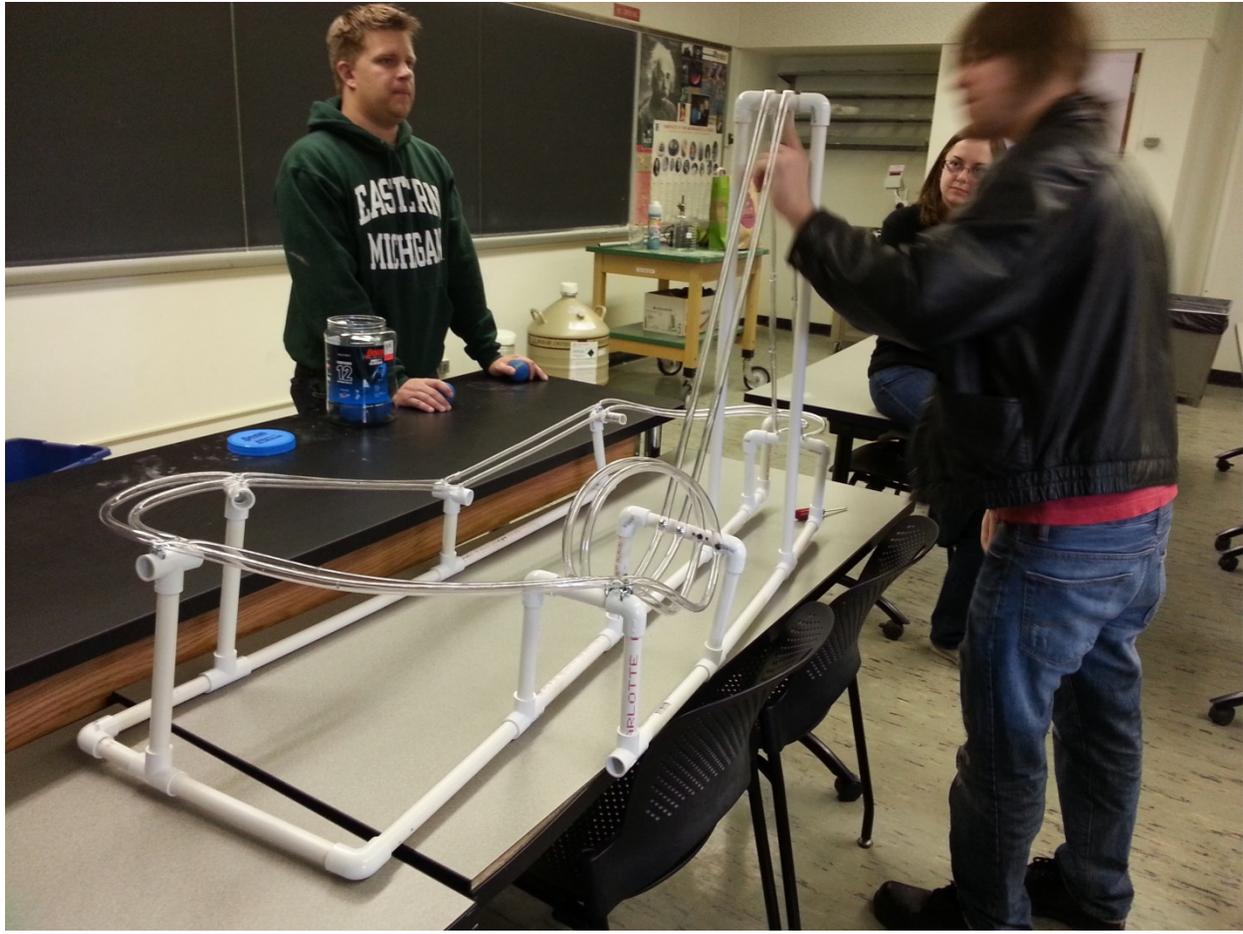
* Eastern Michigan University Physics Department bought these for the department with our own money. They are included in the expenses because their main intended use is for this kind of activity for students.

We also purchased a high quantity to support activities like this one for many more years.

Pictures







Our SPS advisor checking out the only completed rollercoaster.