



SPS Chapter Research Award Final Report

Project Title	Foucault Pendulum
Name of School	Universidad Autónoma de Ciudad Juarez
SPS Chapter Number	3291
Total Amount Awarded	\$1,980.00
Total Amount Expended	
Project Leader	[This should be the same person listed as Project Leader in your proposal unless you have updated this with the SPS National Office.]

Abstract

Physics students from the Universidad Autonoma de Ciudad Juárez present a proposal to design and build an interactive Foucault Pendulum based on a real time traking-system. Motivations behind the proposal are: Earth's rotation properties in a science museum, development teaching tools of Classical Mechanics and valuable scientific skills.

Statement of Activity

The entire Statement of Activity should be no more than three pages, and organized as follows. Note that some of the information requested may be taken directly from your proposal, but it is anticipated that the research questions, goals, and methods/designs/procedures have evolved over the course of most projects. The information provided in this report should reflect those changes.

Overview of Award Activity

Research question

Students have develop great scientific abilities through the activities related to this project. They are different after this enterprise. They have now: 1) a great scientific curiosity, 2) academic responsibility, 3) critical thinking and 4) a very important teamwork attitude. Students and faculty members are working in curriculum development. Not only for regular physics courses, but also for institutional macro-curriculum. This university is requiring its own Pendulum to installed in our campus. This is apart from Museum's Pendulum. That is way we need a support for the new Pendulum.

Motivation

Regularly in elementary schools, science teachers tell children that earth rotates on its own axis. However, student's scientific interpretation and conceptual understanding is fundamental to develop important knowledge. Students need a demonstration process through the visualization of this phenomena. We believe that design and the implementation of physical demonstrations, suggest a Foucault Pendulum could help in the cognitive process during academic life. A Foucault Pendulum could be a good alternative to: i). Help UACJ's physics students during the process of conceptual understanding, and ii) encourage community to enjoy and achieve scientific knowledge.

Brief description

This research project is based on the design, construction and implementation of a Foucault Pendulum. Design elements built will achieve technology-hardware process. This technology will incorporate not only trajectory tracing sensors, but also the necessary software for graphing the corresponding data on an integrated screen.

Research goals of the project

1. Develop a functional prototype for several academic activities in the Universidad Autónoma de Ciudad Juárez.
2. Make investigation related with the electronic components and materials for the construction of the Foucault Pendulum.
3. Implement a high technology Foucault Pendulum at "La Rodadora" Science Museum.
4. Raise the scientific divulgation, interest and curiosity in Juárez City Community. SPS connection to strengthen the objectives of the SPS this project will also consist in the creation of a web page with free access for anyone who wants to interact and acquire the data provided by the Foucault Pendulum at any time.

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BACKGROUND FOR PROPOSED PROJECT

Currently in science museums and universities it's common to find a Foucault Pendulum as an exhibition piece. This type of pendulum was introduced firstly in 1851 by Michael Foucault given the experimental proof Earth's rotation, hence these devices has a utility in the physics laboratories to the undergrad students because it can useful to demonstrate this fact and the physical principles that govern the the Foucault Pendulum behavior.

The Foucault pendulum consists of a large weight suspended on a cable attached to a point two or more floors above the weight. As the pendulum swings back and forth its plane of oscillation rotates clockwise in the northern hemisphere, convincing the rotation of the Earth. The motion of the Foucault pendulum is the coupling of two periodic motion, the rotation of the Earth and the oscillation of the pendulum leading to a precession. Depending on the relevant parameters, the motion differs in varied conditions, showing periodic or non-periodic motion consequently. With gravity, tension and Coriolis force applied on the cable, the motional equation, due to Newton's Law, is difficult in solution.

Up to now, a lot of researches were focused on the Foucault pendulum, they assumes that the weight could be seen as moving in the horizontal plane and not moving in the vertical direction due to its low-amplitude oscillation and propose the motional equations of the pendulum which can get analytical answer to them.

However, we want mainly concentrated on is how the Foucault pendulum moves in varied relevant conditions, doing a comparison between the theory and experimental results.

EXPECTED RESULTS

Once this project is executed, the following results are expected: It is expected that a interactive Foucault Pendulum with a tracking system in real time, in order to show the rotation of the Earth at the "La Rodadora Science Museum", in Cd. Juaréz, Mexico, in the border area with Texas (Scientific divulgation purposes for all the people en our city). This is a result that we believe is very important to promote scientific culture in our city, so that society values and promotes the development of physics and its applications. This type of projects contributes to the development of physics because it motivates future physicists. The expected pendulum will be interactive, well instrumented and very beautiful that will allow visualizing on a screen its trajectory and its explanation in a visual way. From the academic point of view, this project will be a very useful didactic tool for the Classical Mechanics course, specifically to help to understand the topics of Mechanical of Lagrange and Mechanical of Hamilton, this is because any student of physical can validate their theoretical knowledge with our experimental proposal, which will allow us to validate the theoretical solutions with the experimental observations. Additionally, we will elaborate a list of academic activities that allow to challenge or improve the knowledge of Classical Mechanics of physics students, in order to achieve a more proficient knowledge of Classical Mechanics. The electronics (tracking system in real time) that we will develop to obtain the precise position of the trajectories of our Pendulum (3D), can be incorporated into other experiments of classical mechanics, the previous due to the small and high degree of precision that we expect.

Finally, as a result of the execution of this project we hope that our scientific skills and those of the rest of our classmates will improve, that we gain experience in order to be able to face the study of more challenging problems in physics.

DESCRIPTION OF PROPOSED RESEARCH - METHODS, DESIGN, AND PROCEDURES

- Review of the State of the Art about Foucault Pendulum
- Meetings to determine the specific design of the pendulum.
- Made theoretical calculus for experimental design.
- Buy all materials necessary.
- Build a prototype of the interactive Foucault pendulum.
- Looking additional financing.
- Design an artistic concept for the pendulum, through industrial designers.
- Meeting with advisors for feedback, and Write and submit interim report (May 31)
- Meetings to determine the specific design of the real time traking-system.
- Characterization and optimization of the Foucault pendulum.
- Build final Foucault Pendulum, for "La Rodadora" science museum in Mexico. Present and announce this project in our city.
- Verify if results match with expected findings, if not, solve technical problems.
- Diffusion of the project.
- Write and submit the final report (Dec 21).

PLAN FOR CARRYING OUT PROPOSED PROJECT

- Personnel. Four SPS members will be involved in the research of activities: Fernando, Julio, Gabriel and Raúl are the ones who assume the responsibility of the project, designing and executing the activities of the project. Additionally, in January-2019 two more students of physics and two students of Electronic Engineering will be integrated that support with electronics and instrumentation. All the team will be under the supervision of Dr. Abdiel Ramírez-Reyes and Dr. Sergio Flores-García. Finally, there is the support of the personnel in charge of laboratories and workshops of the UACJ.

- Expertise. Fernando, Julio, Gabriel and Raúl has necessary background completion of courses like General Physics, Classical Mechanics and Instrumentation which are helpful to achieve success in the proposed project.
- Research space. The work of this research will be carried out in the Physics Laboratories of the UACJ and in their respective workshops. The final stage of this project will be held at the "La Rodadora Science Museum", in Cd. Juaréz, Mexico, in the border area with Texas

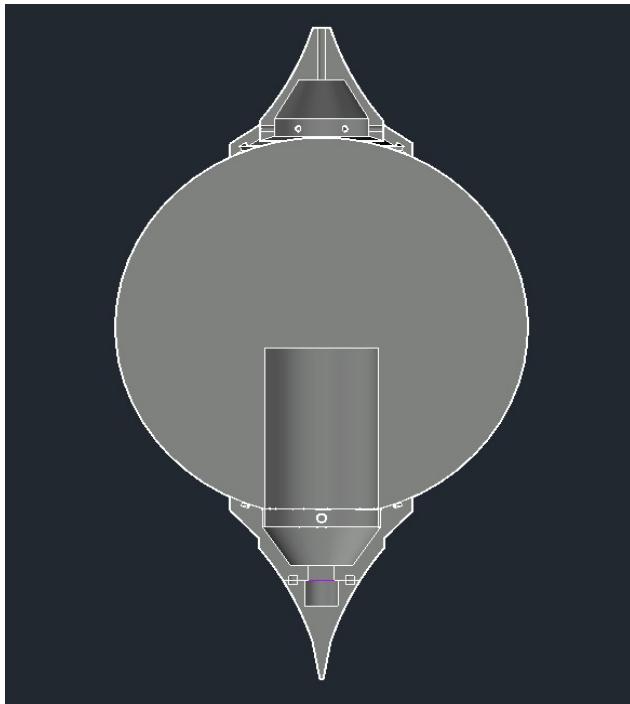
Description of Research - Methods, Design, and Procedures

The work performed in this time lapse was develop the next:

- It makes an experimental design.
- Were bought the left pieces: screws for the superior cone to the above part of the pendulum, cables and clamps for the iron cable, the movement sensor, rechargeable battery, neodymium magnets, plumb pellets.
-
- It sends to fabric the components of our pendulum, which consist in:
 - Hollow sphere of 10 inches and 3 mm of width.
 - A cylindrical structure to place a movement sensor and rechargeable battery.
 - Steel cone and rings for the superior pieces of the pendulum.
 - A modified interior cone to has access to the rechargeable battery.

Also was necessary the help from the manufacture taller where we weld to attach the pieces such that cylinder and the interior ring of our sphere, ass well as the wood taller where was made the next:

The next figure show our design (left image show the model with transversal cut, and right side the physical object coexisting in our final resul).



The choice of the design was thinking for provide the necessary weight with plumb pellets fulling the sphere with it and cavity to place the battery and sensor inside. Also the design it allows transport the pendulum being portable.

Once the sphere was made, we after send it to chrome plated treatment for aesthetic purposes. The inferior part was made with plastic material to extract the signal from inside.

The next images shows the different parts of the pendulum:





Discussion of Results

The pendulum was built and is ready to be installed in the museum where it will be exhibited, as well as, it should be noted that earlier this month we obtained the support of the state government from the institution of "innovation" of \$ 10,000 dollars for the construction of an artistic projection plane

Dissemination of Results

<https://www.spsnational.org/sites/default/files/Interim%20Report.pdf>

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Impact Assessment:

Students have developed great scientific abilities through the activities related to this project. They are different after this enterprise. They have now: 1) a great scientific curiosity, 2) academic responsibility, 3) critical thinking and 4) a very important teamwork attitude. Students and faculty members are working in curriculum development. Not only for regular physics courses, but also for institutional macro-curriculum. This university is requiring its own Pendulum to be installed in our campus. This is apart from Museum's Pendulum. That is why we need a support for the new Pendulum Scientific Curiosity

People develop a scientific curiosity and are in contact with scientific knowledge we could invite people to become a physicist through this activity. Finally, this is one of the most important population outreach activities.

How the Project Influenced your Chapter

This section should include your reflections on:

- The overall experience – Was this experience worthwhile? What are the biggest lessons you/your chapter learned? What surprises did you encounter along the way? How will this experience influence future research projects?
- The SPS connection – How did the activity strengthen your SPS chapter and your physics department?
- What advice would you give to chapters applying for future SPS Chapter Research Awards?

Key Metrics and Reflection

How many students from your SPS chapter were involved in the research, and in what capacity?	4
Was the amount of money you received from SPS sufficient to carry out the activities outlined in your proposal? Could you have used additional funding? If yes, how much would you have liked? How would the additional funding have augmented your activity?	yes, it was enough for the realization of the project as in the proposal if we use aid funds to be able to carry out the most innovative and lucid project, we receive the amount of \$ 10,000 more, with this we will make an artistic projection plan
Do you anticipate continuing or expanding on this research project in the future? If yes, please explain.	That's right, we will fix the project longer, because some parts of the project could not be completed because we promised to do it even better than planned, and give it a better image
If you were to do your project again, what would you do differently?	basically everything was perfect, we only changed providers

Press Coverage (if applicable)

We still have no publicity of the project, due to the setbacks, but it is intended in the future to give a national diffusion at the level of TV and scientific articles

Expenditures

the information in the following table

Expenditure Table

Item	Please explain how this expense relates to your project as outlined in your proposal.	Cost
Sphere	Fundamental piece	110.92
Cromado	Aesthetic treatment	211.28
Magnets	To attach the inferior part	12.15
Cones and cylinder	Place the movement sensor and battery	117.65
Sensor	Adquisition of position	554.60
Plumb pellets	Provide the necessary weight	529.20
Sandpaper packs	Aesthetic treatment	13.68
Bateria recargable	Energy source	12.57
USB cable	Conect the components	8.35
Wood structure	Works to transport the pendulum in an easy way	21.13
3D print	Cono inferior del pendulo	31.68
Cement and sand	To design a structure for work with the sphere.	18.17
Pieces of plumb	Weight of teh pendulum	34.17
Stainless steel cable and clamps	Attach the pendulum	107.53
Total of Expenses Covered by SPS Funding		

Activity Photos

