

Expanding the PEC With Virtual Experiments

September 18, 2017

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Special thanks to:
Jim Stango and Rich Misura

Learning Objectives

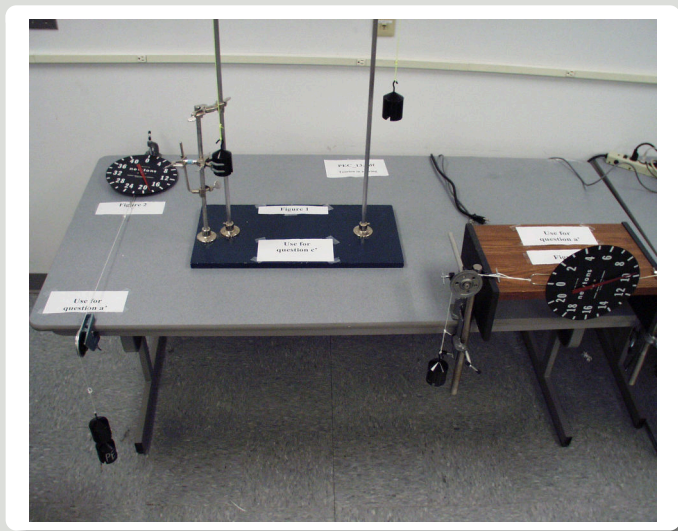
- 1 The Physics Exploration Center
 - Background
 - Motivation for the Project
 - Planned New Labs
- 2 3D 360° Video
 - Equipment
 - How Does 3D 360° Video Work?
 - Anticipated Challenges
- 3 Evaluation and the Future
 - Measurable Outcomes
 - Future: VR Labs for Other Classes

Physics Exploration Center

- Target audience is students in intro physics
- Typically extra credit
- ≈ 1 lab/class/week
- 32 labs total
- Worksheets
- Mostly unsupervised



Example Lab



Limitations

- Equipment must be complete safe to use
- Equipment must be easy to use
- Equipment must be cheap and relatively small
- Some students will “mess up” the equipment anyway
- Students often “blame the equipment” if the results of lab don't agree with their expectations

Virtual Labs

Why Video?

- Avoids limitations on unsupervised equipment usage
- Multiple takes means the experiment will definitely “work”
- Students can review the experiment at anytime

Why 3D 360° Video?

- Many phenomena are inherently 3D
- Large field of view
- It's cool

Project Overview

Fall 2017

- Setup space for VR labs
- 6 new labs (Physics 1)
- Initial student feedback

Spring 2018

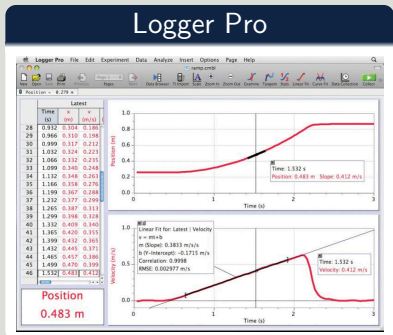
- 6 new labs (Physics 2)
- Evaluate measurable goals
- Additional student feedback



Typical Lab Format

Student Experience

- Read lab description
- Make initial predictions
- View video with VR headset
- Analyze data with *Logger Pro*
- Evaluate initial predictions
- Answer follow-up questions



Planned Labs for Physics 1

- Bowling ball pendulum (forces, energy)
- Shoot ping-pong ball through pop can (work)
- Thrust vs. time for model rocket motor (impulse)
- 2D collision between air pucks (momentum)
- Spin fidget spinner until it breaks (rotation)
- Crush 50 gallon drum using air pressure (ideal gas law)

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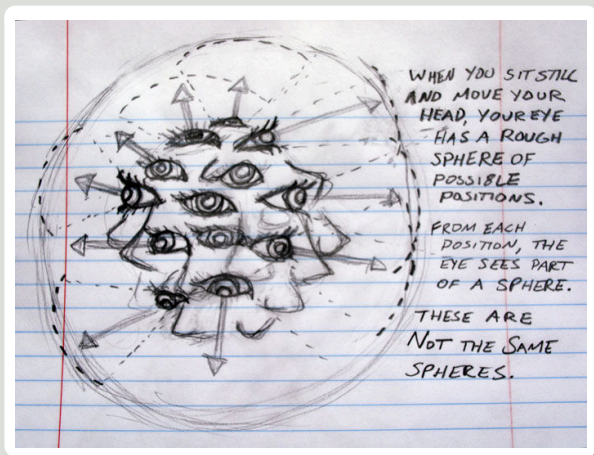
New Equipment



- 2× Oculus Rift headsets
- 2× Dell PCs to drive headsets
- Insta360 Pro 3D 360° camera

Live Demo

How Does 3D 360° Video Work? (And How Doesn't It?)



eleVR.com

Also see optical illusion video

Anticipated Challenges

- Making the headsets + software be intuitive to use
- Scratched lenses?
- Motion sickness?
- Long term: avoiding theft of equipment

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Measurable Outcomes

My goal is to **expand** the PEC, not replace it.

Are Virtual Labs as Beneficial as Hands-On?

- Student feedback
- PEC survey (Singh 2002)
(see next slide)
- Concept inventories for Physics 2
(CSEM + a few extra questions from ECCE)

Strongly Disagree Strongly Agree

- | | | | | | |
|---|---|---|---|---|---|
| 1. Incorporation of hands-on activities improved my physics learning because it provided concrete experiences with physical phenomena. | 1 | 2 | 3 | 4 | 5 |
| 2. The exploration homework problems often helped me clear my misconceptions about a physical phenomena. | 1 | 2 | 3 | 4 | 5 |
| 3. The self-paced nature of PEC was very useful. | 1 | 2 | 3 | 4 | 5 |
| 4. The exploration homework problems were challenging and thought-provoking. | 1 | 2 | 3 | 4 | 5 |
| 5. It was easier to interpret the exploration homework problems compared to the textbook problems because the equipment was in front of me. | 1 | 2 | 3 | 4 | 5 |
| 6. The exploration homework problems were useful in helping me build physical intuition about physical phenomena. | 1 | 2 | 3 | 4 | 5 |
| 7. The exploration problems made physics seem closely linked with everyday situations. | 1 | 2 | 3 | 4 | 5 |
| 8. The exploration problems were more interesting and meaningful compared to the textbook problems. | 1 | 2 | 3 | 4 | 5 |
| 9. It is possible to have "fun" while learning physics. | 1 | 2 | 3 | 4 | 5 |
| 10. In this course, I learned how and why the physical world behaves the way it does. | 1 | 2 | 3 | 4 | 5 |
| 11. The exploration problems increased my desire to learn physics. | 1 | 2 | 3 | 4 | 5 |
| 12. I hope to be able to relate concepts learned in this physics course with phenomena that occur in everyday situations long after this course is over. | 1 | 2 | 3 | 4 | 5 |
| 13. Factors such as room size, PEC hours, equipment, staff, and availability of other resources were effective in providing an ideal learning environment in PEC. | 1 | 2 | 3 | 4 | 5 |
| 14. Overall, exploration homework problems were an effective supplement to lectures. | 1 | 2 | 3 | 4 | 5 |

What feature of PEC did you like most?

Future: VR Labs for Other Classes

As the library of available VR software grows, the VR lab can see usage in courses throughout the department.

Mission ISS



Apolo 11 VR



Thank You!