**Introduction**

Magnetorquer wrapping is an important part of satellite systems and how efficiently they are when placed into orbit to record and transmit various types of information such as weather, life, dangers, and data for space missions. It is important to teach the public and school children about magnetorquers and other satellites as most do not know how they receive most of their information. This project aimed to develop a lesson plan with in-class activities to teach 4th graders about magnetorquers and satellites that are launched into space.

Topics included in the lesson plan address science/engineering practices, disciplinary core ideas, and crosscutting concepts.

**NGSS**
- Asking questions and defining problems
- Defining and delimiting engineering problems
- Influence of science, engineering, and technology on society and the natural world

**Methods**

This project had three phases:

1. **Researching Magnetorquers and Satellites**

   Background research on the topic of developing effective satellites, procedures, and lesson plans included reading various articles, manuals, and books by engineers at the NASA Ames Research Center, as well as attending public lectures by leading NASA engineers and scientists. In addition, weeks of training was also needed before stepping into the lab, then observations were required for more in depth learning where notes were recorded in detail.

2. **Lab work for the magnetorquer wrapping**

   The field work was conducted with full-time and collegiate level engineers at NASA’s Jet Propulsion Lab in the Electrostatic Discharge room. Where NASA engineers try to better understand how to make satellites more effective and efficient than their last models, and why their previous models were not as successful as they wanted them to be, as well as improving their designs for future models. Our field work focused on designing and building a CubeSat satellite that would be ready to launch by a set date. Once the lab work was completed a written procedure was needed to inform future engineers who may encounter the project on how, what, when, and why to perform the magnetorquer wrapping for a CubeSat satellite.

3. **Development of lesson plan and classroom activity**

   The research conducted included extensive note taking and during field work was used to develop a lesson plan about satellites and magnetorquer wrapping with a connection to human lifestyle. The lesson plan includes a short article, worksheet, and a hands-on project for students, that engages them in a simulation where they design and create their own satellite.

**Results of the Magnetorquer Wrapping**

The lesson plan that was created during this internship is based on field work conducted through reading various books, articles, and engaging in various training workshops. Through the activities outlined in this lesson plan students and teachers gain an insight about the satellites and magnetorquer wrapping and the impact they have on everyday human living. The lesson plan includes a short article, worksheet, and hands-on project that students complete to help them better understand satellites and magnetorquer wrapping and their relationship to each other and to human lifestyle.

**Results - Lesson Plan**

Included in the lesson plan:
- Lesson Description
- Performance Expectations
- Phenomena
- Essential/Driving Question
- Specific Learning Outcomes
- How they will be assessed
- Science & Engineering Practices
- Disciplinary Core Ideas
- Crosscutting Concepts
- Lesson Integration
- Lesson Relevance
- Lesson Opportunities
- Build Knowledge

Activity included in the lesson plan:
- Short Article
- Discussion
- Worksheet
- Design their satellite
- Create their satellite

**Conclusions**

As a teacher-in-training it has been invaluable to engage in scientific research. In-class observations has significantly influenced my understanding of how people learn and my capacity to communicate effectively. When shadowing a veteran teacher, I noticed children were highly interested and more engaged when they were able to touch relevant objects. In addition, I noticed the importance of color and purposeful lessons that make things interesting. It was clear that 4th grade students love to be actively engaged, which in turn motivated me to develop a hands-on activity. The goal of this project was to teach 4th grade students about the power of satellites and their importance in our lives. The hands-on activities combined with the illustrated booklet will help teachers to do so effectively.

**References**


**Acknowledgements**

I would like to thank the STAR program and NASA Ames Research Center for hosting me this summer and for allowing me to fulfill my goals. In addition, I would like to thank the STAR program, Dr. A. Courchesne, Richard W. Timmerman, Chris C. Roark, Ali Guarneros Luna, Marcus Murbach, King Dingie, Raynew Whiteman, Bill T. Myers, Benny Chan, and Frank C. Yang for volunteering on this project.

I would also like to thank the Innovative Power Technologies for the use of the power supplies and the team at STP for sponsoring the effort. In addition, I would like to thank the National Science Foundation, California State University San Jose, National Science Initiatives, Center for Astronomy and Space Science Education, California State University, San Jose, and the National Marine Sanctuary Foundation for their support.

I would like to thank the student of the STAR program and NASA Ames Research Center for hosting me this summer and for allowing me to fulfill my goals. In addition, I would like to thank the STAR program, Dr. A. Courchesne, Richard W. Timmerman, Chris C. Roark, Ali Guarneros Luna, Marcus Murbach, King Dingie, Raynew Whiteman, Bill T. Myers, Benny Chan, and Frank C. Yang for volunteering on this project.

[Image of TES 7 Extrusion]

[Image of Brackets on TES 7 for Magnetorquer Wrapping]

[Image of Completed Magnetorquer Wrapping]

[Image of Solar panels used to power TES 7]

[Image of Solar panels on top of Magnetorquer Wrapping]

[Image of TES 7 doing the vibration test]