

Daniel Soto Spring 2025 DIP report

My DIP application proposed the construction and publication of physical demonstrations of electric motor characteristics as well as the development of my digital skills for technical illustrations and animations.

I submitted a paper on a demonstration of motor torque to journal *The Physics Teacher* in March. This work built on a demonstration I developed for my energy laboratory course. During my DIP I designed and constructed new elements for the demonstration to improve the repeatability of the results. The demonstration uses a frictionless cradle with axial rotation and a weighted balance arm to demonstrate a torque balance and its variation with the applied electrical current. The submitted work includes example data sets and analysis to facilitate the use of the apparatus in the reader's classes. The submission also includes videos of the torque balance being achieved.

I made progress on a revision of an existing bicycle electric generation demonstration. In the original demonstration, students generate electricity using a bicycle with an electric wheel motor. Students see that motors can generate electricity and experience how strenuous it is to create modest amounts of electrical energy. This demo draws interest from students but a significant fraction of potential participants opt not to ride the bicycle. Suspecting this is because of the physical difficulty of mounting a bicycle, we decided to construct a hand-crank, tabletop version. I purchased a more advanced wheel motor for this demo to allow for electronic data collection of speed and torque.

During my DIP leave, I designed and constructed a prototype frame to replace the bicycle frame and hold the wheel motor and crank fixed on a table top. The prototype frame consists of wooden dowels and 3D-printed connectors. By designing parametric models of these connectors, I can quickly create custom frames of different sizes and angles for other projects. I also increased my 3D-modeling skills through the project.

I created a computer code library for to-scale drawings for mathematics exercises. In my data analysis class, I've used ad-hoc scripts to create number lines, shapes, and graphs in PDF format with true-to-scale dimensions. These drawings support exercises where students integrate their formulas with measurements of these objects. During my leave, I created an organized software library to make it easier to create and modify these drawings and exercises. Through this project I increased my knowledge of graphics creation and code design.

I've started the integration of these scholarship products into my upcoming courses. I've revised all of my data analysis drawings and exercises to use this new software library. I expect this to reduce the time and effort to revise and create these drawings and exercises in my Fall 2025 data analysis course. I plan to use the hand-crank motor apparatus in a quantitative demonstration of electrical generation in my Spring 2026 energy course.

While I spent much of my DIP in solo scholarship, I continued my community engagement work. I presented a simple motor lesson to a group of youth at a community STEAAM event presented by the [Infinite Learning and Resource Center](#). Students used both the bicycle generator and a simple generator apparatus I built from a skateboard motor and small light bulbs.

I also continued my community engagement work in environmental justice and in the energy transition. Our environmental justice community-academic partnership, P4ER, worked with two SSU students to plan a 2-day EJ workshop with our youth partners through the North Bay Organizing Project which we delivered in early June 2025. My co-authors and I completed the revision, resubmission, and publication of a manuscript, [“Transforming the University into a Public Good for Environmental Justice Action”](#), which argues that the mission and incentives at universities like SSU are a good fit for local environmental justice efforts. In addition to my participation on the Sonoma Clean Power Community Advisory Committee, I arranged meetings with selected SCP staff members to see how I and SSU could support SCP's various efforts in the clean energy space. These relationships will likely result in relevant case studies and project topics for SSU students in my energy classes.

