From Kick to Current: Engineering a Smart E-Scooter with High School Students (Resource Exchange)

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Matthew Aldeman serves as the founding Associate Dean of the ISU College of Engineering, where he leads the first year engineering program and the General Engineering undergraduate major. Prior to the College of Engineering, Aldeman served as an Associate Professor in the ISU Department of Technology, where he taught in the Sustainable & Renewable Energy and Engineering Technology programs and served as program coordinator for the Sustainable & Renewable Energy program. Matt joined the Technology department faculty after working at the ISU Center for Renewable Energy for five years. Before coming to ISU, he worked at General Electric as a wind project site manager at the Grand Ridge and Rail Splitter wind projects in central Illinois. Matt's experience also includes service in the U.S. Navy as a nuclear propulsion officer, leader of the Reactor Electrical division on the aircraft carrier USS John C. Stennis, and Gunnery Officer on the destroyer USS O'Bannon. Matt is an honors graduate of the U.S. Naval Nuclear Power School and holds a B.S. in Mechanical Engineering from Northwestern University, a Master of Engineering Management from Old Dominion University, and a Ph.D. in Mechanical and Aerospace Engineering from the Illinois Institute of Technology.

Dr. Jin Ho Jo

Dr. Jin Ho Jo is a Professor of Technology at Illinois State University, teaching in the Sustainable and Renewable Energy program. Dr. Jo also leads the Sustainable Energy Consortium at the university. Dr. Jo is an honors graduate of Purdue University, where he earned a B.S. in Building Construction Management. He earned his M.S. in Urban Planning from Columbia University, where he investigated critical environmental justice issues in New York City. His 2010 Ph.D. from Arizona State University was the nation's first in sustainability. His research, which has been widely published, focuses on renewable energy systems and sustainable building strategies to reduce the negative impacts of urbanization.

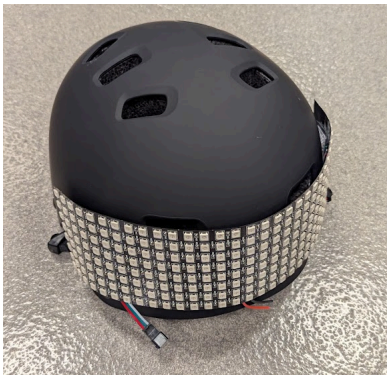
From Kick to Current: Engineering a Smart E-Scooter with High School Students

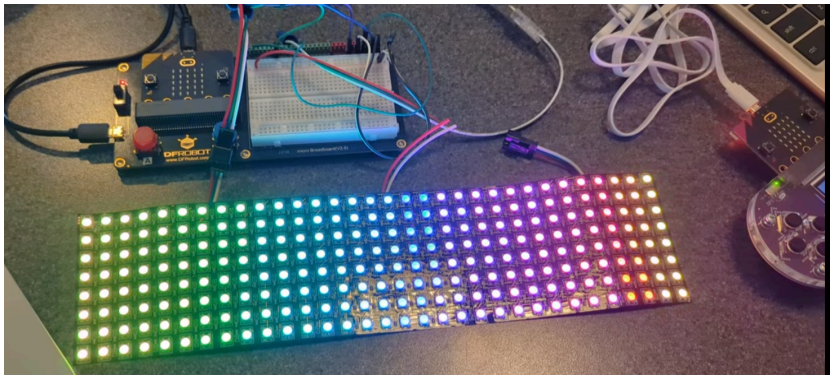
This resource details a hands-on project for students in grades 9-12, designed for 90-minute sessions in informal settings such as after-school programs over the course of one school year. Rather than simply building from a kit, students engage in an iterative engineering design process to solve urban commuting challenges. The project serves as an engaging capstone activity for a multi-year curriculum focused on sustainability through the integration of multiple engineering disciplines. The activities were designed by undergraduates so that secondary students could get a glimpse of what a college-and-career pathway in these emerging fields looks like.

Overview of The Conversion Process: From Kick to E-Scooter

The conversion process requires students to move through several critical engineering steps:

1. **Mechanical Audit:** Evaluating the kick scooter frame to identify mounting points for the circuits and battery system.
2. **Hardware Retrofitting:** Installing the drive system and securing the electrical hardware to the chassis.
3. **Coding the "Odometry" Interface:** Students write custom Micro:bit code to translate physical wheel rotations into digital speed data.
4. **Systems Integration:** Integrating wireless communication so the handlebar input triggers the correct turn signal on the rider's helmet.





Project Insights: Experiences & Challenges

One of the most engaging moments for students is developing the speed tracking logic. They must apply mathematical concepts to relate wheel circumference to the frequency of a digital read pin. Seeing their manual calculations successfully update a real-time display as they move the scooter provides a tangible "aha!" moment that connects learning to the real world.

Within this project, community partnerships and the exploration of pathways were significant focuses. Periodic workshops and summer camps were held to connect students and educators with opportunities to bring their STEM knowledge back to their communities. Experts from the university and community partnerships also engaged with students to discuss the importance of safety.

Safety First! Safety considerations explored in this unit:

- **Mechanical Integrity:** During modifications to "bike" hardware, students must verify that the scooter frame and components remain structurally sound.
- **Electrical Retrofitting:** Students learn how to ensure that all circuit connections are securely fastened to prevent short circuits or other failures.
- **Field Testing:** Students learn the “rules of the road” before performing performance tests in a controlled environment with riders wearing proper safety gear, including the student-integrated LED helmets.

Pre-Build Activities

This resource also includes access to several “pre-build” activities designed around the theme of smart and sustainable transportation systems!

Find these activities and more freely shared at :

about.IllinoisState.edu/SUPERCHARGE

This work is supported by the US National Science Foundation Award No. 2148429