2026 Global Design Challenge

Secondary

Deadline: December 15, 2026

Lights for Us, Darkness for Them: Engineers Protect the Night

Secondary STEM Council

Overview:
In 2008, the U.S. National Academy of Engineering (NAE) identified 14 Grand Challenges for Engineering in the 21st Century. The Grand Challenges were designed to inspire students and educators to think about solutions to the big challenges affecting us all. ITEEA's Secondary STEM Council is again sponsoring the Global Design Challenge (GDC) to provide students with a chance to solve a real problem, apply the engineering design process, and demonstrate how engineering can address complex human and environmental needs.

Scenario:
For years, your community has worked to protect a wooded habitat that is home to owls and other nocturnal wildlife. The area has become an important place for conservation, recreation, and environmental education. The owls are especially valued by the community, and their continued presence is viewed as a sign that the habitat remains healthy.

Recently, the community expanded access to the area by creating a network of walking and biking paths. As more people began using the trails in the early morning and evening, concerns arose about visibility and safety. In response, outdoor lighting was installed along several sections of the trail.

The lighting improved visibility for people, but it also created an unintended consequence. Artificial light now extends beyond the trail and into areas of the owl habitat that were previously dark at night. Community leaders want to address the problem, but simply removing the lights is not an acceptable solution. People still need to safely navigate the trails after sunset.

The community is asking engineering teams to develop a better solution, one that balances human safety with the nighttime conditions needed by owls and other nocturnal wildlife.

Challenge:
Students, working as an engineering design team, design, build, test, and optimize a model lighting solution that provides appropriate illumination along a recreational trail while minimizing artificial light entering the adjacent owl habitat. Your team must use quantitative evidence to demonstrate the effectiveness of the final design and justify the trade-offs made during the engineering design process.

Suggested Materials:

flashlight, work light, drop light, LEDs, wire, LED light strips, motion sensors, batteries, LED light source, or another teacher-approved light source; graph or grid paper; measuring tools; low-cost, recycled, repurposed, or readily available materials; and a consistent method for collecting quantitative light data. A phone or tablet light-sensor application, classroom light sensor, or inexpensive lux meter may be used when available.

Limitations:

1. The designated trail must remain illuminated at a level established by the team and justified with evidence.
2. The amount of artificial light reaching the designated owl habitat must be reduced from the baseline condition.
3. The solution must use an artificial light source. Teams may not solve the problem simply by turning the light off.
4. The solution must remain stable and function without a person holding it in place.
5. The light source, model dimensions, measurement locations, and environmental conditions must remain consistent during comparative trials.
6. Teams must conduct a baseline test, test at least one prototype, redesign or optimize the solution based on evidence, and conduct a final test.
7. Teams must collect quantitative data at multiple predetermined locations in both the trail zone and owl-habitat zone.
8. Teams must consider trade-offs among pathway illumination, habitat protection, stability, materials, cost, and overall performance.

Testing:

Students should create a scaled model containing two clearly marked areas: a recreational trail where people need light and an adjacent owl habitat where unnecessary artificial light should be minimized. Establish multiple fixed measurement points in both zones. Mark the position, height, and angle of the light source so the setup can be reproduced for every trial.

1. Conduct a baseline test with the light source operating and no student solution installed. Measure and record illumination at each designated trail and habitat measurement point.
2. Build and install the first prototype. Repeat the measurements using the same light source, position, angle, room conditions, and measurement locations.
3. Analyze the data. Identify where the design succeeds and where it does not. Use the evidence to redesign or optimize the solution.
4. Install the final design and repeat the complete test. Conduct multiple trials to determine whether the results are consistent.
5. Compare the baseline, prototype, and final-design data. Use the results to demonstrate whether the final solution maintains useful trail illumination while reducing unwanted light in the owl habitat.

Quantitative analysis

Student teams should report illumination measurements for each test point and calculate summary values for the trail and habitat zones. At minimum, teams should determine the average illumination in each zone before and after installing the final solution.

Percent Reduction = ((Baseline Habitat Illumination - Final Habitat Illumination) / Baseline Habitat Illumination) × 100

Teams may also calculate a Useful Light Ratio to compare how effectively their design directs light toward the trail rather than the protected habitat.

Useful Light Ratio = Average Trail Illumination / Average Habitat Illumination

A larger ratio indicates that more of the measured light is reaching the area where it is needed rather than the protected habitat. Teams must interpret their results rather than rely on a single number. A design that greatly reduces habitat light but leaves the trail inadequately illuminated has not fully solved the problem.

Potential ways for students to conduct the test:

- Use a phone or tablet light-sensor application, classroom light sensor, or inexpensive lux meter to measure illuminance at marked locations. Use the same device throughout the investigation.
- Create a measurement grid with fixed points along the trail and within the owl habitat. Record illumination at every point for the baseline, prototype, and final design.
- Create a light-distribution map or graph showing how illumination changes across the model.
- Calculate average trail illumination and average habitat illumination for each design iteration.
- Calculate the percent reduction in unwanted habitat illumination compared with the baseline.
- Calculate and compare the Useful Light Ratio for different design iterations.
- Test the final design with the light source in more than one predetermined location or orientation to evaluate reliability.
- Repeat final measurements for multiple trials and report variation or consistency in the results.
- Document material use and estimated cost, then consider whether additional performance justifies additional complexity or expense.

To evaluate criteria, ask student to answer the following questions:

- **Effectiveness:** Does the solution substantially reduce unwanted artificial light reaching the owl habitat?
- **Trail Illumination:** Does the design maintain appropriate illumination where people need it?
- **Quantitative Evidence:** Has the team collected, analyzed, and accurately interpreted data that demonstrate performance?
- **Optimization:** Has the team used testing evidence to improve the design and balance competing criteria?
- **Stability and Reliability:** Does the solution remain securely positioned and perform consistently across repeated trials?
- **Creativity:** Has the team developed an innovative approach to managing light?
- **Resourcefulness:** Has the team used materials, cost, and complexity effectively?
- **Trade-offs:** Explain compromises among human safety, habitat protection, performance, materials, and cost.
- **Presentation:** Clearly communicate the problem, engineering design process, failures, data, redesign decisions, and final solution.

Teacher Notes:

1. Introduce the challenge through literature, media, or research about owls, nocturnal wildlife, nighttime habitats, and artificial light at night.
2. Discuss unintended consequences of technology. The installed lighting solved a human safety problem but created a new environmental design problem.
3. Emphasize that the goal is not to eliminate artificial lighting. Students are engineering where and how light is delivered.
4. Require teams to establish their measurement procedure before beginning prototype comparisons. Consistency in measurement is essential for meaningful data.
5. Encourage students to graph or map their illumination data and use evidence, rather than appearance alone, to make redesign decisions.
6. Use the engineering design process throughout the challenge, including defining the problem, establishing criteria and constraints, ideating, modeling, prototyping, testing, analyzing, redesigning, optimizing, and communicating.
7. Create a student-led video, 3 minutes maximum, in which students explain the community problem, show baseline data, describe a failure or limitation of an early design, explain how evidence informed redesign, and demonstrate the quantitative performance of the final solution.
8. Encourage teams to discuss uncertainty and limitations in their testing method. Different devices may report different absolute light values, so comparative testing should use the same measurement device and conditions.

Content Information for Teachers:

- **Unintended consequences of technology:** Unexpected results that occur when a technology designed to solve one problem creates a new problem or affects people, animals, or the environment in an unforeseen way.
- **Artificial light at night:** Human-produced nighttime lighting that changes naturally dark conditions.
- **Light pollution:** Artificial light that is excessive, unnecessary, misdirected, or reaches places where it is not needed.
- **Illuminance:** The amount of light reaching a surface. Illuminance is commonly measured in lux.
- **Reflection:** The change in direction of light when it strikes a surface and returns into the surrounding environment.
- **Diffusion:** The scattering of light in many directions as it interacts with a material or surface.
- **Light trespass:** Unwanted artificial light that extends beyond the area intended to be illuminated.
- **Optimization:** Improving a design to achieve the best possible balance among multiple criteria and constraints.
- **Other concepts for class discussion:** nocturnal habitats, owl ecology, optics, angle of incidence and reflection, directionality, glare, shielding, transparency, opacity, inverse-square relationships, measurement uncertainty, environmental design, systems thinking, sustainability, human factors, trade-offs, and life-cycle considerations.

Incorporating Literature and Research:

Use literature and informational sources that help students understand owls, nocturnal wildlife, nighttime habitats, and the environmental effects of artificial light at night. Secondary teams may also investigate existing outdoor lighting practices and wildlife-sensitive lighting approaches as part of their research while developing an original solution.

Submission

- Submit a student-led, three-minute maximum video. It should include the problem, engineering design process, quantitative testing evidence, redesign, and demonstration of the final solution.
- Submit the video to **ssc@iteea.org** with the subject line: "GDC 2026 Video - Secondary Submission - [School Name]" by December 15, 2026.

The winning team will receive a free one-year Group Membership for their school, an invitation to be part of ITEEA's 2027 STEM Showcase, and one free hotel night at the 2027 Louisville Conference.

For questions about the Global Design Challenge, contact: **ssc@iteea.org**.

Standards for Technological and Engineering Literacy (STEL):

Standard 1: Nature and Characteristics of Technology and Engineering

Grades 6-8
S. Defend decisions related to a design problem.

Grades 9-12
T. Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making.
X. Cite examples of the criteria and constraints of a product or system and how they affect final design.

Standard 4: Impacts of Technology

Grades 6-8
K. Examine the ways that technology can have both positive and negative effects at the same time.

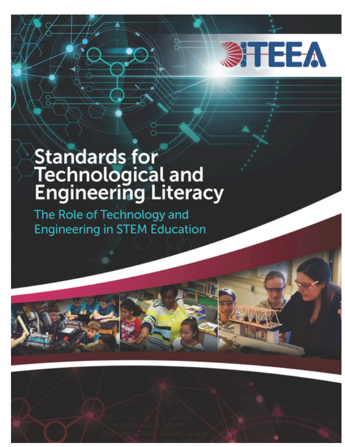
Grades 9-12
IP. Evaluate ways that technology can impact individuals, society, and the environment
S. Develop a solution to a technological problem that has the least negative environmental and social impact.

Standard 5: Influence of Society on Technological Developmental Products and Systems

Grades 6-8
G. Evaluate trade-offs based on various perspectives as part of a decision process that recognizes the need for careful compromises among competing factors.

Grades 9-12
H. Evaluate a technological innovation that arose from a specific society's unique need or want.

Standard 7: Design in Technology and Engineering Education



Grades 6-8
Q. Apply the technology and engineering design process.
R. Refine design solutions to address criteria and constraints.

Grades 9-12
X. Document trade-offs in the technology and engineering design process to produce the optimal design.
Y. Optimize a design by addressing desired qualities within criteria and constraints.