Engineering in Action: Safe Crossing
Grades: K-5
Time: 50 minutes

Engineering Challenge: Students will plan, build, and test a structure that will allow animals to safely navigate a model roadway.

Rationale and Context
This program aims to inspire conversation and awareness around the survival challenges native animals are facing due to human impact on the natural environment, as well as the ways scientists, engineers, and policymakers are trying to mitigate those effects. Students will use the Engineering Design Process (EDP) to define and construct a playful solution to the problem of habitat fragmentation that animals are facing in Vermont and around the world. The EDP is a series of steps that engineers employ to develop solutions to a given problem. It is a cyclical process that can be applied to any problem requiring a technological solution. Many of the environmental challenges facing the Lake Champlain Basin benefit from engineered technologies, such as management of invasive species and stream monitoring. Students will come to see that the EDP can be used to solve problems in a diversity of contexts and themselves as possessing the ability to design and improve technologies.

Teacher Background Information
As human populations continue to grow and expand into more remote areas, habitat fragmentation has become a larger and larger problem for Vermont's native species. According to the Vermont Fish and Wildlife Department, habitat fragmentation "means dividing land with naturally occurring vegetation and ecological processes into smaller and smaller areas as a result of roads, land clearing, development, or other land uses that remove vegetation and create physical barriers to species' movement and ecological processes between previously connected natural vegetation." Artificial barriers can significantly impact species like black bears, otters, deer, bobcats, and others that need large tracts of land to thrive. These animals, along with many smaller species like frogs and salamanders, are then faced with the challenge of crossing barriers (if possible) to follow migratory routes, find food or water, or seek out potential mates. For obvious reasons, crossing roads, in particular, poses great risk to many of these species. Depending on the health of different animal populations, even a small increase in mortality could have a significant impact.

However, many scientists, engineers, and policymakers are working together to reduce animal road mortality, not just in Vermont but around the world. Scientists continue to study wildlife movements and identify high-traffic areas of greatest impact. Engineers and policymakers work together to plan, design, fund, and construct solutions at these identified areas. For example, fences to divert wildlife and warning signs alerting motorists to potential hotspots have been used successfully for many years. More recently, a variety of animal overpasses and underpasses are being planned and constructed, such as on Interstate 89 in Waterbury. Scientists and volunteers even work together on rainy spring nights to slow down traffic and move vulnerable migratory amphibians across roads safely.

The Engineering Design Process

Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. The Engineering Design Process (EDP) is a set of steps engineers follow to solve problems. Steps include: Define, Plan, Build, Evaluate, and Revise. The process is designed to be cyclical with students repeating the steps as many times as necessary to refine their ideas. Fundamental to this process is the ability of students to solve problems creatively and work together. Typically solutions involve designing a product that meets certain criteria and possible solutions to a problem are limited by the available materials and resources (constraints). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success. Different solutions need to be tested in order to determine which of them best solves the problem.

NGSS Standards

Disciplinary Core Ideas	
ESS3.A: Natural Resources	Living things need water, air, and resources from the land, and they live in places that have the things they need.
ESS3.C: Human Impacts on Earth Systems	Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things.
LS2.C: Ecosystem Dynamics, Functioning, and Resilience	When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.

LS4.D: Biodiversity and Humans	Populations live in a variety of habitats, and change in those habitats affects the organisms living there.
ETS1.A: Defining and Delimiting Engineering Problems	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
ETS1.B: Developing Possible Solutions	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
ETS1.C: Optimizing the Design Solution	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
Science and Engineering Practices	
Define a simple problem.	
Engage in the design cycle to construct a solution that meets a specific design goal.	
Plan and carry out fair tests in which variables are controlled.	
Communicate information and design ideas with others.	
Crosscutting Concepts	
Systems and Models	
Structure and Function	
Cause and Effect	

Learning/Behavioral Objectives

1. Students will discuss the ways that humans can impact the world around them.
2. Students will investigate the problems that human infrastructure can cause to wildlife.
3. Students will design and build a solution that lets animals safely cross roads.
4. Students will use the EDP to collaboratively plan and build a solution, taking into account available material/time constraints and criteria for success.
5. Through testing and group discussion, students will evaluate their designs.
6. Students will revise their solutions, considering how the structure of their original designs impacted their function.

Vocabulary

Constraint	Habitat	Structure
Design	Migration	Survival
Engineering	Range	Wildlife
Fragmentation	Shelter	

Focusing Questions

1. What do animals need to survive?
2. What is a habitat?
3. How do humans change their habitats to make their lives better/easier?
4. How can human structures impact wildlife?
5. How can humans lessen the impact of their structures on wildlife?
6. How can we use the Engineering Design Process to solve problems in everyday life?
7. How do groups of people work together to solve problems?