SD Department of Transportation
TRAC School Resource Agreement

The **TR**ansportation **A**nd **C**ivil Engineering Program is a hands-on educational outreach program. This math and science program is designed to expose 7-12th grade students to the work world of the transportation industry and the Civil Engineering discipline. The TRAC modules are gifted to the school by the South Dakota Department of Transportation (DOT) for the duration of time they are actively using the material. If the school is no longer using the modules, they are to be returned to the DOT.

Please select the modules you are interested in.

- ☐ **Bridge Builder Module**
- ☐ **Design and Construction Module**
- ☐ **Environmental Module**
- ☐ **Traffic Engineering & Safety Module**
- ☐ **Magnetic Levitation (MagLev) Module**
- ☐ **Motion Module**
- ☐ **Traffic Technology Module**

TEACHER'S NAME: _____

GRADE _____SUBJECT(S) _____

SCHOOL NAME _____DISTRICT _____

MAILING ADDRESS FOR SCHOOL: _____

PHONE _____

EMAIL _____

PRINCIPAL'S NAME_____ School's Phone #_____

E-MAIL ADDRESS _____

I give my permission for the teacher named above to utilize the program in the classroom and agree to return the materials when no longer being used.

PRINCIPAL'S SIGNATURE: _____

EMAIL AGREEMENT TO: SDTRAC@state.sd.us
MAIL AGREEMENT TO: SDDOT, TRAC Program 700 East Broadway Ave. Pierre SD 57501.

TRAC™ and RIDES *Program Fast Facts*

TRAC and RIDES, AASHTO's educational outreach programs, are designed for use in Science, Technology, Engineering, and Math (STEM) classes. The hands-on activities introduce students in grades K–12 to the work world of transportation and civil engineering and inspire them to consider careers in those fields. Both programs are aligned with national standards. State departments of transportation work with schools in their state by providing the curricula and resources for the schools as well as providing engineers to visit the classrooms to serve as speakers, teach a hands-on activity, and or talk to students about the importance of math and science in preparing for their future.

Leading by Example.

TRAC (Transportation and Civil Engineering)

Teachers are supplied with a "Transportation Research Activities Center" or TRAC PAC. The latest version is TRAC PAC 2, seven self-contained education modules featuring professionally developed curricula that meet national standards of learning. Each module contains the equipment, software and supplies needed to perform up to 75 hands-on activities related to:

- Bridge Design • Highway Safety
- Magnetic Levitation • Design and Construction • Motion
- Environmental Engineering, and
- Traffic Technology

RIDES (Roadways In Developing Elementary Students)

Teachers attend two days of hands-on training and receive a curriculum aligned with National Math and Science Standards. The units titled *Transportation and Energy, Roadway Geometry, Humans and Nature,* and *Designing Ways* take students on multiple adventures learning about transportation in relation to both math and science concepts. Activities include classification, sequencing, measuring, graphing, predicting, inferring and experimenting.

Program Structure

- State Departments of Transportation pay a membership fee of $14,000 annually
- DOTs recruit schools to use the TRAC Program and place TRAC PACs in the schools
- Volunteer transportation professionals and civil engineers from the DOT and private sector work directly with teachers and students in the classroom to support the TRAC Curricula, enhance the teachers' lessons, and mentor the students.

AASHTO

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BRIDGE BUILDER *Building Math Skills*

TRAC™
Leading by Example

This module meets the following National Standards of Learning

National Science Education Standards: Physical Science

Grades 6–12

Science as Inquiry

- Identify questions that can be answered through scientific investigations.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Use technology and mathematics to improve investigations and communications.
- Think critically and logically to make the relationships between evidence and explanations.

Abilities of Technological Design

- Identify appropriate problems for technological design.
- Design a product.
- Implement a proposed design.
- Evaluate completed technological designs or products.

Activities

Activity 1: Structural Concepts

Activity 1 is an interactive computer-based introduction to the basic concepts employed by a structural engineer when designing and building bridges.

Activity 2: Beam Me Up

Activity 2 involves three in-class demonstrations that illustrate some of the key structural concepts that are essential to understanding how basic bridges behave.

Activity 3: Bridge Analysis

Activity 3 consists of two parts. The first part serves as an introduction to the theory behind how engineers determine how much force is transferred to each member of a truss from the force applied to the structure. The second part of Activity 3 gives the students an introduction to computer-based design.

Activity 4: Draft it Up!

Activity 4 is a drafting activity utilizing Bentley Microstation PowerDraft v8i software. This activity will provide students with a basic introduction to CAD software.

Activities 5 and 6: Basic & Improved Box Bridge Structures

Activities 5 and 6 allow the students to take part in hands-on activities that guide them through the process of building their own bridges, which they will test in class as part of a design competition.

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AASHTO

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ENVIRONMENTAL MODULE *Understanding It*

This module meets the following National Standards of Learning

National Science Education Standards: Physical Science

Grades 5–8

Science as Inquiry

- Identify questions that can be answered through scientific investigations.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Use technology and mathematics to improve investigations and communications.
- Think critically and logically to make the relationships between evidence and explanations.
- Formulate and revise scientific explanations and models using logic and evidence.

Grades 9–12

Science as Inquiry

- Design and conduct scientific investigations.
- Use technology and mathematics to improve investigations and communications.
- Formulate and revise scientific explanations and models using logic and evidence.
- Recognize and analyze alternative explanations and models.

National Educational Technology Standards for All Students

Technology Foundation Standards for Students

Basic Operations and Concepts

Students are proficient in the use of technology.

Technology Productivity Tools

Students use technology tools to enhance learning, increase productivity, and promote creativity.

Students use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.

Technology communications tools

Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.

Technology Research Tools

Students use technology to locate, evaluate, and collect information from a variety of sources.

TRAC PAC 2

This module contains three activities to provide a comprehensive overview of environmental considerations in highway design.

Activities

Activity 1: Settling Out

Activity 1 addresses particle size in relation to settling rate in still water.

Activity 2: Filtering the Silt

In Activity 2, students implement a filtering efficiency test model used by engineers to determine what filter fabric is most effective in catching suspended particles in runoff.

Activity 3: The Connector Highway Project

Activity 3 considers four major issues (air pollution, noise pollution, water quality, and habitat loss) often included in the judgment of environmental quality of a populated area.

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TRAFFIC ENGINEERING AND SAFETY *The Physics of Highway Safety*

This module meets the following National Standards of Learning

National Science Education Standards: Physical Science

Grades 6–12

Science as Inquiry

- Identify questions that can be answered through scientific investigations.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Use technology and mathematics to improve investigations and communications.
- Think critically and logically to make the relationships between evidence and explanations.

Abilities of Technological Design

- Identify appropriate problems for technological design.
- Design a product.
- Implement a proposed design.
- Evaluate completed technological designs or products.

TRAC PAC 2

This module contains four activities to provide a comprehensive overview of the planning and design of roads for traffic considerations.

Activities

Activity 1: Quick Fixes for High-Crash Highways

Activity 1 provides students with an introduction to traffic management and road improvement planning.

Activity 2: Quick Curves

Activity 2 is a hands-on project showing the importance of curve design.

Activity 3: Sharp Curve Ahead!

Activity 3 takes a mathematical approach to explaining curve design. Students will learn equations that are used by engineers to design curves and will explore the concepts that are used to formulate those equations.

Activity 4: Create a Plan!

Activity 4 provides students with a plan of obstacles that they must navigate by creating roads with known speed limits. These roads must pass through the given intersection points and must be designed properly through the application of engineering equations.

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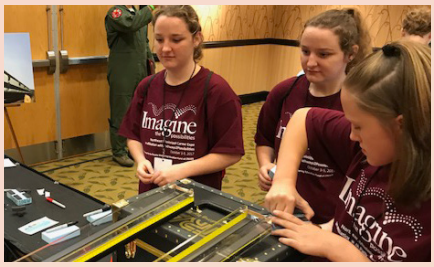
MAGNETIC LEVITATION *Learning Is on the Rise*



This module meets the following National Standards of Learning

National Science Education Standards: Physical Science

Grades 5–8

Science as Inquiry

- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Use technology and mathematics to improve investigations and communications.
- Think critically and logically to make the relationships between evidence and explanations.
- Formulate and revise scientific explanations and models using logic and evidence.

Grades 9–12

Science as Inquiry

- Design and conduct scientific investigations.
- Use technology and mathematics to improve investigations and communications.
- Formulate and revise scientific explanations and models using logic and evidence.
- Recognize and analyze alternative explanations and models.

Technology Foundation Standards

Basic Operations & Concepts

Students demonstrate a sound understanding of the nature and operation of technology systems.

Students use technology tools to enhance learning, increase productivity, and promote creativity.

Students use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.

Students employ technology in the development of strategies for solving problems and making informed decisions in the real world.

TRAC PAC 2

Magnetic Levitation (MagLev) may sound like science fiction, but the fact is, this technology is relevant in today's middle school general science classes and high school physics classes.

This module contains five activities to provide a comprehensive overview of basic physics concepts as they apply to moving vehicles.

Activities

Activity 1: Timing Newton's Apple

Activity 1 demonstrates to students that there is some reaction time required to perform an action, no matter how instantaneous the response may seem.

Activity 2: Running the Gauntlet

In Activity 2, students verify Newton's First Law by observing how a maglev car moves with minimal resistance from friction.

Activity 3: Caution—6% Grade Ahead

Activity 3 explores Newton's Second Law and introduces the concept of acceleration due to gravity through observation of how gravity affects vehicles traveling on an inclined surface.

Activity 4: Graphing the Grade

Activity 4 explores Newton's Second Law and introduces the concept of acceleration due to gravity.

Activity 5: Float Like a Butterfly, Sting Like a Bee

In this activity, students will use the skills they have learned to create and race maglev cars.

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MOTION MODULE *Physics on the Move*

This module meets the following National Standards of Learning

National Science Education Standards: Physical Science

Grades 5–8

Science as Inquiry

- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Use technology and mathematics to improve investigations and communications.
- Think critically and logically to make the relationships between evidence and explanations.
- Formulate and revise scientific explanations and models using logic and evidence.

Science Content

Motion and Forces

The motion of an object can be described by its position, direction of motion and speed. That motion can be measured.

If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.

Grades 9–12

Science as Inquiry

- Design and conduct scientific investigations.
- Use technology and mathematics to improve investigations and communications.
- Formulate and revise scientific explanations and models using logic and evidence.
- Recognize and analyze alternative explanations and models.

Science Content

Motion and Forces

Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects.

TRAC PAC 2

This module contains six activities and covers the educational topics of momentum and impulse that are normally taught in a high school physics course or an intermediate school physical science course. Transportation topics include automobile collision analysis and roadside crash barrier design.

Activities

Activity 1: Bump N Run

Activity 1 demonstrates the Law of Conservation of Momentum for middle school students using a series of collisions between maglev cars of different mass.

Activity 2: Calculated Collisions

Activity 2 introduces students to the concept of momentum and how to calculate the velocity and momentum of the maglev cars before and after the collisions.

Activity 3: Collision Analysis

Activity 3 requires students to use the Law of Conservation of Momentum to solve for specific variables.

Activity 4: Impulse

Activity 4 introduces the concept of impulse and involves two demonstrations.

Activity 5: Egg Drop

Activity 5 is a hands-on activity in which students are given a limited number of materials to build a structure that will protect an egg during falls from increasing heights.

Activity 6: Major Impacts

Activity 6 is a hands-on activity in which students design and build a crash barrier. The barriers are then tested on an inclined track by a vehicle impacting the barrier.

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DESIGN & CONSTRUCTION *On the Road to Learning*

This module meets the following National Standards of Learning

Activity 1: How Much Traffic Can the Road Handle?

National Council of Teachers of Mathematics Standards

The algebra standard indicates students should use "mathematical models, including graphs, tables, and equations."

Activity 2: Not in My Backyard!

National Council for the Social Studies Standards

Strand 8 Science, Technology, and Society: (relationships among science, technology, and society) asks "How can we manage technology so that the greatest number of people benefit from it?"

Activity 3: How Much Does It Cost?

National Council of Teachers of Mathematics Standards

The Data Analysis and Probability Standard indicates that students should "understand scatterplots and use them to display data ... conduct analyses of the relationships between two sets of measurement data ...produce lines that fit the data .... [and] discuss what best fit might mean"

TRAC PAC 2

This module contains four activities to provide a comprehensive overview of the design and construction of roadways.

Activities

Activity 1: How Much Traffic Can the Road Handle?

Activity 1 consists of two sections that explain the concept of traffic flow rates at varying traffic densities and also demonstrates how there is a maximum number of cars able to move through a lane within an hour.

Activity 2: Not in My Backyard!

Activity 2 asks students to determine how to align a road that will go from point A to point B on a map, given that there is no optimal location for the road.

Activity 3: How Much Does It Cost?

Activity 3 uses a map to explain how real estate prices are determined.

Activity 4: Construction Estimating

Activity 4 is an exercise in estimating the cost of construction, including labor, equipment, material, overhead, and profit.

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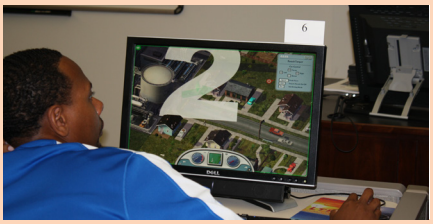
TRAFFIC TECHNOLOGY *Giving Science the Green Light*



This module meets the following National Standards of Learning

National Science Education Standards

Grades 5–8

Science as Inquiry

- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Use technology and mathematics to improve investigations and communications.
- Think critically and logically to make the relationships between evidence and explanations.
- Formulate and revise scientific explanations and models using logic and evidence.

Standards for Technology Literacy

Standard 8: Students will develop an understanding of the attributes of design

Standard 9: Students will develop an understanding of engineering design.

Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Grades 9–12

Physical Science Content Standard B

Motion and Forces

- Its position, direction of motion and speed can describe the motion of an object. That motion can be measured.
- If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.

Science as Inquiry

- Design and conduct scientific investigations.
- Use technology and mathematics to improve investigations and communications.
- Formulate and revise scientific explanations and models using logic and evidence.
- Recognize and analyze alternative explanations and models.
- Motion and forces: Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects.

TRAC PAC 2

This module contains five activities to provide students an understanding of technology applications in Traffic Engineering, as well as understand the factors behind reaction time and stopping distance.

Activities

Activity 1: Calculating Reaction Time

In Activity 1, the concept of reaction time is taught to students through the application of linear motion.

Activity 2: Braking Distance and Friction

Activity 2 studies the concept of braking distance by exploring the relationship between kinetic energy of a moving car and work done to bring the car to a stop.

Activity 3: Setting Yellow Light Time

In Activity 3, the concept of linear motion is applied to the duration of the yellow light time on a traffic signal by tying together reaction time and braking distance.

Activity 4: Programming Logic for Traffic Systems

Activity 4 introduces students to software programming, as it applies to traffic technology.

Activity 5: Shortest Path

Activity 5 explores how modern map applications determine the quickest route between two locations. Students will use Microsoft Excel to calculate the quickest route on a maze based on the distance between different path options.

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