SUPPLEMENTAL MATERIALS FOR USE WITH EDUCATION VIDEOTAPES

BY

John J. Schemmel, Ph.D., P.E., Hannah Shepard,
Frances Griffith

MBTC-9202
June 2007

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave Blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	Submitted to MBTC on June 1, 2007	Final Report – January 1, 2001 – August 31, 2002

4. TITLE AND SUBTITLE

SUPPLEMENTAL MATERIALS FOR USE WITH EDUCATION VIDEOTAPES

5. FUNDING NUMBERS

6. AUTHOR(S)

John J. Schemmel, Ph.D., P.E., Hannah Shepard, Frances Griffith

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Mack-Blackwell Rural Transportation Center
4190 Bell Engineering Center
University of Arkansas
Fayetteville, AR 72701

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

US Department of Transportation
Research and Special Programs Administration
400 7th Street, S.W.
Washington, DC 20590-0001

10. SPONSORING/ MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

Supported by a grant from the U.S. Department of Transportation University Transportation Centers program

12a. DISTRIBUTION/AVAILABILITY STATEMENT

12b. DISTRIBUTION CODE

N/A

13. ABSTRACT (MAXIMUM 200 WORDS)

Three videotapes on the profession of civil engineering were produced in 1996 under a grant from MBTC. The objectives were to educate children about professions in transportation and civil engineering in an interesting, age-appropriate way as well as to help educators explain the role of civil engineers in our society. The tapes have been widely disseminated and very well received.

Although the objectives of producing the videotapes have been met, the tapes provide only a quick look at the profession. Moreover, elementary teachers and counselors may find it challenging to incorporate the content of the videos into more formal classroom activities. Thus, the proposed project will develop materials to increase the usefulness of the two videotapes directed to K-8 students. Materials may include an Internet site, reference and descriptive documents, science projects, math exercises, displays, coloring books, or similar items.

Two types of materials will be developed. First, descriptive information will be prepared on such topics as civil engineering sub-disciplines, potential employers, types of employment, academic requirements, and professional organizations. Second, classroom materials will be developed that apply engineering principles and knowledge, such as projects, homework assignments, and coloring books. These documents will give students a better sense of what it takes to become a civil engineer as well as insight into the challenges and rewards of the profession.

Copies of completed materials will distributed to individuals who received the original videotapes. They will also be used in existing outreach programs of the University of Arkansas' civil engineering department.

14. SUBJECT TERMS	15. NUMBER OF PAGES 230
	16. PRICE CODE N/A

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
none	none	none	N/A

Standard Form 298

Technical Report Documentation

1. Report Number MBTC - 9202	2. Government Access No.	3. Recipient's Catalog No.
4. Title and Subtitle **SUPPLEMENTAL MATERIALS FOR USE WITH EDUCATION VIDEOTAPES**		5. Report Date Submitted to MBTC on June 1, 2007
		6. Performance Organization Code
7. Author(s) **John J. Schemmel, Ph.D., P.E., Hannah Shepard, Frances Griffith**		8. Performing Organization Report No.
9. Performing Organization Name and Address Mack-Blackwell Rural Transportation Center 4190 Bell Engineering Center University of Arkansas Fayetteville, AR 72701		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address US Department of Transportation Research and Special Programs Administration 400 7th Street, S.W. Washington, DC 20590-0001		13. Type of Report and Period Covered Final Report – January 1, 2001 – August 31, 2002
		14. Sponsoring Agency Code

15. Supplementary Notes

Supported by a grant from the U.S. Department of Transportation University Transportation Centers program

16. Abstract

Three videotapes on the profession of civil engineering were produced in 1996 under a grant from MBTC. The objectives were to educate children about professions in transportation and civil engineering in an interesting, age-appropriate way as well as to help educators explain the role of civil engineers in our society. The tapes have been widely disseminated and very well received.

Although the objectives of producing the videotapes have been met, the tapes provide only a quick look at the profession. Moreover, elementary teachers and counselors may find it challenging to incorporate the content of the videos into more formal classroom activities. Thus, the proposed project will develop materials to increase the usefulness of the two videotapes directed to K-8 students. Materials may include an Internet site, reference and descriptive documents, science projects, math exercises, displays, coloring books, or similar items.

Two types of materials will be developed. First, descriptive information will be prepared on such topics as civil engineering sub-disciplines, potential employers, types of employment, academic requirements, and professional organizations. Second, classroom materials will be developed that apply engineering principles and knowledge, such as projects, homework assignments, and coloring books. These documents will give students a better sense of what it takes to become a civil engineer as well as insight into the challenges and rewards of the profession.

Copies of completed materials will distributed to individuals who received the original videotapes. They will also be used in existing outreach programs of the University of Arkansas' civil engineering department.

17. Key Words	18. Distribution Statement
Education and training, Education, Study and teaching, school children, Persons by educational level, Students, Elementary school students, High school students	No restrictions. This document is available from the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Cassif. (of this page)	21. No. of Pages	22. Price
unclassified	unclassified	230	N/A

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Thumbnail Images

transportation

<<BACK

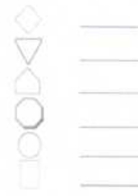
>>MORE

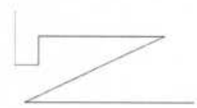
Civil Engineering - A Bridge to the Future

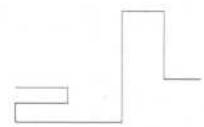
Thumbnail Images

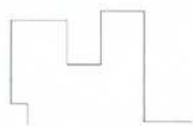
transportation

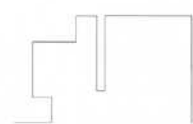
<<BACK











Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

Thumbnail Images

structures

BACK

>>MORE












Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

Thumbnail Images

structures

<<BACK

>>MORE












Civil Engineering - A Bridge to the Future

Thumbnail Images

structures

<<BACK









Civil Engineering - A Bridge to the Future

HOME
>>MORE

3rd Through 5th Grade

Environmental

You Wont Know What You've Got Till It's Gone
I'm Stuck on You
What? I Can't Hear You

Geotechnical

Can You Be Spread Too Thin?
How Do You Like Your Soil?
It's Percolating Water, Not Coffee

Structures

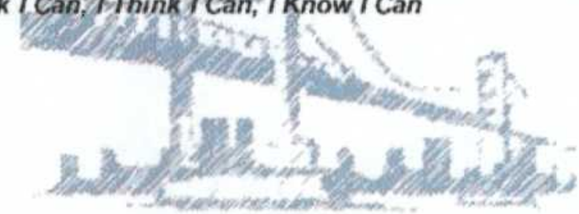
Push, Pull, Or Drag It In
Sponge Beam Squared Shape
The Bridges Of Paper County

Surveying

Let Me Level With You
You've Got To Keep Up The Pace
Measuring Objects from a Distance

Transportation

Which Way Do I Go?
Vital Signs
I Think I Can, I Think I Can, I Know I Can



Civil Engineering - A Bridge to the Future

3rd Through 5th Grade

Civil Engineering - A Bridge to the Future

LESSON PLANS AND ACTIVITIES

3rd to 5th Grade

ENVIRONMENTAL

Lesson #1 – You Wont Know What You've Got Till Its Gone

Lesson #2 – I'm Stuck On You

Lesson #3 – What? I Can't Hear You

GEOTECHNICAL

Lesson #1 – Can You Be Spread Too Thin?

Lesson #2 – How Do You Like Your Soil?

Lesson #3 – It's Percolating Water, Not Coffee!

STRUCTURES

Lesson #1 – Push, Pull, Or Drag It In

Lesson #2 – Sponge Beam Square Shaped

Lesson #3 – The Bridges Of Paper County

SURVEYING

Lesson #1 – Let Me Level With You

Lesson #2 – You've Got To Keep Up The Pace

Lesson #3 – In The Eye Of The Beholder

TRANSPORTATION

Lesson #1 – Which Way Do I Go?

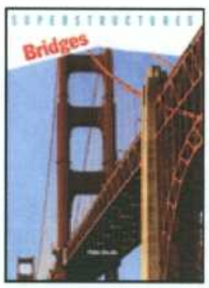
Lesson #2 – Vital Signs

Lesson #3 – I Think I Can, I Think I Can, I Know I Can

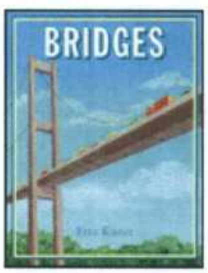
Book List

3rd-5th Grade

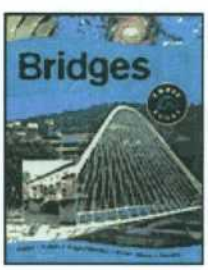
Air Pollution
Rhonda Lucas, Lucas Donald
Format: Library Binding, 48pp.
ISBN: 0516221914
Publisher: Children's Press
Pub. Date: September 2001
Recommend Age Range: 8 to 10



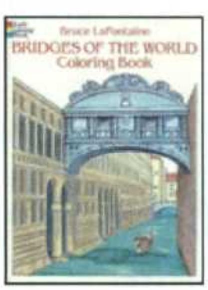
Bridges
Chris Oxlade
Format: Hardcover,48pp.
ISBN: 0817243313
Publisher: Raintree Publishers
Pub. Date: February 1997
Recommend Age Range: 12 and up



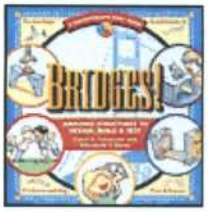
Bridges
Etta Kaner, Pat Cupples (Illustrator)
Format: Paperback, 214pp.
ISBN: 1550741462
Publisher: General Distribution Services, Inc.
Pub. Date: April, 1997
Recommend Age Range: 8 to 12



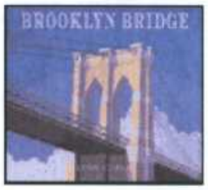
Bridges
Nicola Baxter
Format: Hardcover,32pp.
ISBN: 0531145492
Publisher: Watt, Franklin
Pub. Date: March 2001
Edition Desc: 1 AMER ED
Recommend Age Range: 7 to 10



Bridges of the World Coloring Book
Bruce LaFontaine
Format: Paperback
ISBN: 0486283585
Publisher: Dover Publications, Incorporated
Pub. Date: February 1995
Recommend Age Range: 4 to 8

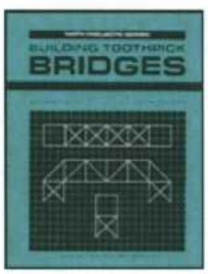


Bridges!: Amazing Structures to Design, Build and Test
Carol A. Johmann, Elizabeth J. Rieth, Michael P. Kline (Illustrator)
Format: Paperback, 96pp.
ISBN: 1885593309
Publisher: Williamson Publishing Company
Pub. Date: October 1999
Recommend Age Range: 12 and up



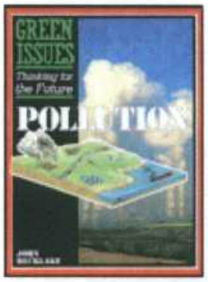
Brooklyn Bridge
Lynn Curlee
Format: Hardcover, 1st ed.,35pp.
ISBN: 0689831838
Publisher: Simon & Schuster Children's
Pub. Date: April 2001
Edition Desc: 1 ED
Recommend Age Range: 8 to 12

Build It!: Activities for Setting up Super Structures
Keith Good
Format: Hardcover, 30pp.
ISBN: 082253567X
Publisher: Lerner Publishing Group
Pub. Date: September 1999
Recommend Age Range: 12 and up

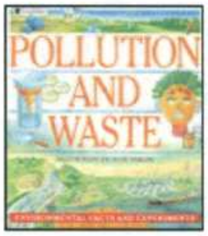


Building Toothpick Bridges: Grades 5-8
Jeanne Pollard, J. Pollard
Format: Paperback, 32pp.
ISBN: 0866512667
Publisher: Dale Seymour Pubn
Pub. Date: June 1985

Exploring Forces and Structures
Keith Bardon, Marilyn Clay (Illustrator)
Format: Hardcover, 48pp.
ISBN: 0811426025
Publisher: Steck-Vaughn
Pub. Date: October 1992
Recommend Age Range: 12 and up

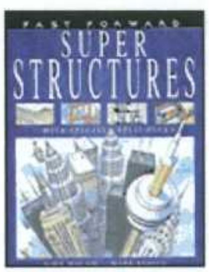


Pollution
John Becklake, Sue Becklake
Format: Library Binding, 40pp.
ISBN: 0531172333
Publisher: Watts Franklin
Pub. Date: January 1990
Recommend Age Range: 12 and up

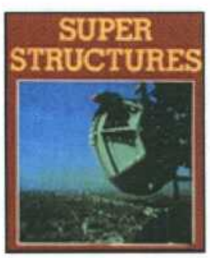


Pollution and Waste: Environmental Facts and Experiments
Rosie Harlow, Sally Morgan
Format: Hardcover, 1st ed., 32pp.
ISBN: 1856976149
Publisher: Kingfisher Publications, plc
Pub. Date: September 1995
Edition Desc: 1st American ed
Recommend Age Range: 7 to 10

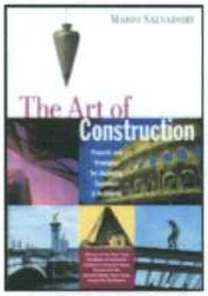
Structures and Materials
Barbara Taylor, Peter Millard (Illustrator)
Format: Hardcover, 32pp.
ISBN: 0531141861
Publisher: Watts Franklin
Pub. Date: October 1991
Recommend Age Range: 9 to 11



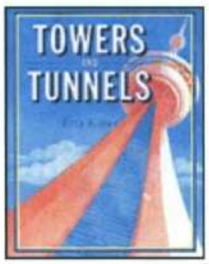
Super Structures
John Malam, Mark Bergin (Illustrator), Created by David Salariya
Format: Paperback, 32pp.
ISBN: 0531164411
Publisher: Scholastic Library Publishing
Pub. Date: September 2000
Recommend Age Range: 12 and up



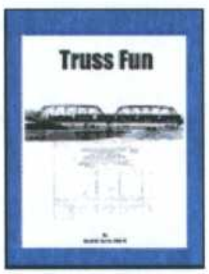
Super Structures
Paul Nash, Peter Harris (Editor)
Format: Library Binding, 31pp.
ISBN: 0944483372
Publisher: Garrett Educational Corporation
Pub. Date: July 1989
Edition Desc: Revised Edition
Recommend Age Range: 7 to 9



The Art of Construction: Projects and Principles for Beginning Architects and Engineers 3rd ed
Mario G. Salvadori, Christopher Ragus, Saralinda Hooker
Format: Textbook Paperback, 1st ed.,160pp.
ISBN: 1556520808
Publisher: Chicago Review Press
Pub. Date: March 1990
Edition Desc: 3rd ed



Towers and Tunnels
Etta Kaner, Pat Cupples (Illustrator)
Format: Paperback, 190pp.
ISBN: 1550742183
Publisher: General Distribution Services, Inc.
Pub. Date: April 1997
Recommend Age Range: 8 to 12



Truss Fun
David W. Harri,s Library of Congress, John Maxwell Collection
Format: Paperback, 144pp.
ISBN: 0967549507
Publisher: BaHa Enterprises, LLC
Pub. Date: December 2000
Barnes & Noble Sales Rank: 225,898

No Picture

Water Pollution
Rhonda Lucas, Lucas Donald
Format: Paperback, 48pp.
ISBN: 0516273574
Publisher: Scholastic Library Publishing
Pub. Date: March 2002
Recommend Age Range: 8 to 10

Vocabulary List

3rd-5th Grade

---

air pollution
airplane
asphalt
automobile
beam column
boat
bridge
bus
cantilever beam
car
compression
concrete
dead load
directions
East
environmental
erosion
estimation
exact measurement
feet
foundation
geotechnical

horizontal
land
landslides
left
live load
load
map
measure
miles
neutral axis
noise pollution
North
pollution
right
road sign
roadbed
roads
sand dunes
school crossing
soil
solid waste pollution
South

stiffness
stop light
stop sign
structures
survey
tension
torsion
traffic
train
transportation
travel
vehicle
vertical
waste water pollution
water
water erosion
water weight erosion
West
wind erosion
wood
yards
yield sign

Activities and Lesson Plans

by sub-discipline

- **Environmental**
- **Structural**
- **Geotechnical**
- **Transportation**
- **Surveying**

by grade grouping

- **K to 2nd**
- **3rd to 5th**
- **6th to 8th**

Production Credits

Thumbnail Images

construction

BACK











Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

Thumbnail Images

construction equipment

BACK

Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

Thumbnail Images

construction materials

BACK

>>MORE









Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

Thumbnail Images

environmental

BACK
>>MORE











Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

BACK

Thumbnail Images

environmental

Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

Thumbnail Images

geotechnical

BACK

>>MORE











Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

Thumbnail Images

geotechnical

<<BACK

>>MORE











Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

Thumbnail Images
geotechnical

<<BACK
>>MORE








Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

- **Environmental**
- **Structural**
- **Geotechnical**
- **Transportation**
- **Surveying**

by grade grouping

- **K to 2nd**
- **3rd to 5th**
- **6th to 8th**

Production Credits

<<BACK

Thumbnail Images
geotechnical









Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

Thumbnail Images

transportation

BACK

>>MORE








Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

Thumbnail Images
transportation

<<BACK
>>MORE





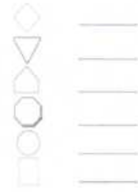


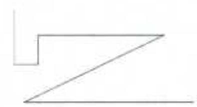

Civil Engineering - A Bridge to the Future

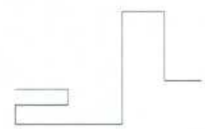
Thumbnail Images

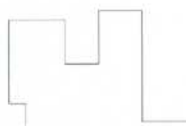
<<BACK

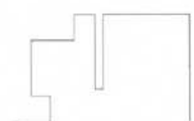
transportation











Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

Thumbnail Images

structures

BACK

>>MORE












Civil Engineering - A Bridge to the Future

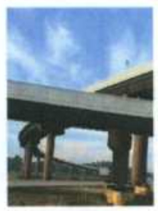
Thumbnail Images

structures












Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

Thumbnail Images

structures

<<BACK









Civil Engineering - A Bridge to the Future

HOME

6th Through 8th Grade

>>MORE

Environmental

Don't Run Off With My Soil !
Space, A Wasteful Frontier
Oil And Anything Don't Mix

Geotechnical

That Crummy Soil
Soil, A Classic
Soil Can Be A Slippery Slope

Structures

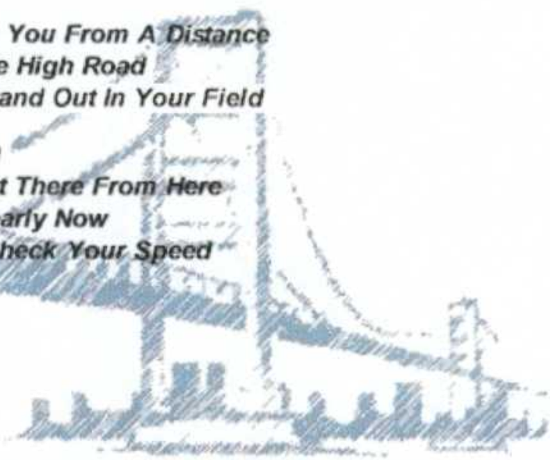
I'm Stuck And Can't Get Down !!
Is That Cement Or Concrete?
How Dense Can You Be?

Surveying

I'm Watching You From A Distance
You Take The High Road
Are You A Stand Out In Your Field

Transportation

You Can't Get There From Here
I Can See Clearly Now
Its Time To Check Your Speed



Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

HOME

6th Through 8th Grade

<<BACK

Index of Lesson Plans

Bibliography

Related Books

Vocabulary List

Introductory Videoclip

Image Library

Civil Engineering - A Bridge to the Future

LESSON PLANS AND ACTIVITIES

6th to 8th Grade

ENVIRONMENTAL

Lesson #1 – Don't Run Off With My Soil!

Lesson #2 – Space, A Wasteful Frontier

Lesson #3 – Oil And Anything Don't Mix

GEOTECHNICAL

Lesson #1 – That Crummy Soil

Lesson #2 – Soil, A Classic

Lesson #3 – Soil Can Be A Slippery Slope

STRUCTURES

Lesson #1 – I'm Stuck And Can't Get Down !!

Lesson #2 – Is That Cement Or Concrete

Lesson #3 – How Dense Can You Be

SURVEYING

Lesson #1 – I'm Watching You From A Distance

Lesson #2 – You Take The High Road

Lesson #3 – Are You A Standout In Your Field?

TRANSPORTATION

Lesson #1 – You Can't Get There From Here

Lesson #2 – I Can See Clearly Now

Lesson #3 – Its Time To Check Your Speed!

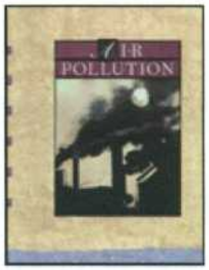
BIBLIOGRAPHY

6th-8th Grade

Heavy Equipment	Erik A. Bruun
The Big Dig	Dan McNichol
Bridges: From My Side to Yours	Jan Adkins
Air Pollution	Michael George
Pollution	Tamara L. Roleff
Environmental Experiments About Water	Thomas R. Rybolt
Garbage and Other Pollution	Virginia Peterson
Ancient Transportation: From Camels to Canals	Michael Woods
Transportation	Nigel Smith
Environmental Experiments about Land	Thomas R. Rybolt
Transport: On Land, Road, and Rail	Eryl W. Davies
The Golden Gate Bridge	Craig A Doherty
Build It!: Activities for Setting Up Super Structures	Keith Good
Building Big	David Macaulay

Book List

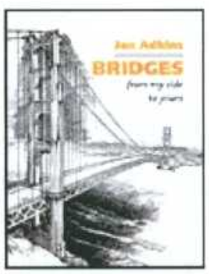
6th-8th Grade



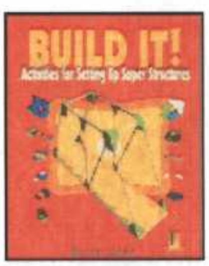
Air Pollution
Michael George Gary Lopez With Charles Rotter
Format: Hardcover, 40pp.
ISBN: 0886824273
Publisher: Creative Company, The
Pub. Date: December 1991

No Picture

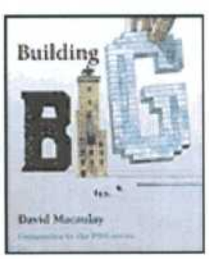
Ancient Transportation: From Camels to Canals
Michael Woods Mary B. Woods
Format: Hardcover, 96pp.
ISBN: 0822529939
Publisher: Lerner Publishing Group
Pub. Date: September 1999



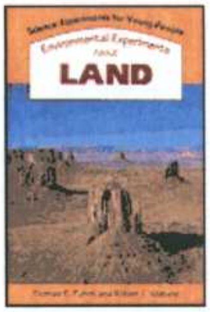
Bridges: From My Side to Yours
Jan Adkins
Format: Library Binding, 96pp.
ISBN: 0761325107
Publisher: Millbrook Press
Pub. Date: March 2002
Edition Desc: 1ST
Other Formats: Hardcover



Build It!: Activities for Setting up Super Structures
Keith Good
Format: Hardcover, 30pp.
ISBN: 082253567X
Publisher: Lerner Publishing Group
Pub. Date: September 1999
Recommend Age Range: 12 and up



Building Big
David Macaulay
Format: Hardcover, 192pp.
ISBN: 0395963311
Publisher: Houghton Mifflin Company
Pub. Date: November 2000



Environmental Experiments about Land
Thomas R. Rybolt Robert C. Mebane
Format: Hardcover, 96pp.
ISBN: 0894904116
Publisher: Enslow Publishers, Incorporated
Pub. Date: September 1993

Environmental Experiments about Water
Thomas R. Rybolt Robert C. Mebane
Format: Library Binding, 96pp.
ISBN: 0894904108
Publisher: Enslow Publishers, Incorporated
Pub. Date: May 1993

No Picture

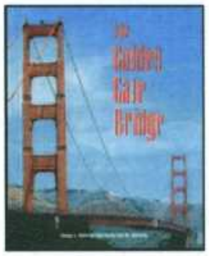
Garbage and Other Pollution: How Do We Live with All the Trash?
Virginia Peterson (Editor) Mark A. Siegel Information Plus
Format: Paperback, 80pp.
ISBN: 1573021059
Publisher: Gale Group
Pub. Date: May 1998
Edition Desc: REVISED

Heavy Equipment: Giant Machines that Crush, Dig, Dredge, Drill, Excavate, Grade, Haul, Pave, Pulverize, Pump, Push, Pull, Roll, Stack, Thresh, and Transport Big Things
Erik A. Bruun Buzzy Keith
Format: Hardcover, 127pp.
ISBN: 188482272X
Publisher: BD&L
Pub. Date: September 1997
Edition Desc: Special Value

No Picture

Pollution
Tamara L. Roleff
Format: Paperback, 244pp.
ISBN: 073770134X
Publisher: Gale Group
Pub. Date: September 1999
Other Formats: Hardcover

The Big Dig
Dan McNichol Andy Ryan (Photographer)
Format: Hardcover, 240pp.
ISBN: 0760723079
Publisher: Sterling Publishing Company, Incorporated
Pub. Date: November 2000
Other Formats: Paperback



The Golden Gate Bridge
Craig A. Doherty Katherine M. Doherty Bruce S. Glassman (Editor)
Format: Hardcover, 1st ed., 48pp.
ISBN: 1567111068
Publisher: Gale Group
Pub. Date: April 1995
Edition Desc: 1st ed

No Picture

Transport: On Land, Road and Rail
Eryl W. Davies
Format: Hardcover, 48pp.
ISBN: 0531152448
Publisher: Watts Franklin
Pub. Date: May 1992

Transportation
Nigel Smith Graham White Rob Shone (Illustrator)
Format: Hardcover, 32pp.
ISBN: 0761306048
Publisher: Millbrook Press
Pub. Date: October 1997

Vocabulary List

6th-8th Grade

---

angle of inclination	dimensions	mode
attribute	dirt	observation
calculation	dispose	permeate
cement	elevation	perpendicular
characteristics	environment	pollution
civil engineering	equivalent	population
classification	erosion	similar triangles
compaction	fabricate	sink hole
compressive load	fertilization	slope stability
compressive strength	foundation	soil
concrete	global positioning system	structural engineer
connections	industrial engineering	surface water runoff
construction site	integrity	surveying
contour line	isoline	tensile load
contour map	joints	tensile strength
corporation	landfill	terrain
decomposition	level line	unit weight
density	logistics	variability
deposited	mechanical	viscosity
devastating	mechanism	volume

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

Thumbnail Images

HOME

select a category below to view the images available in the library on this disk.

Construction

Construction Equipment

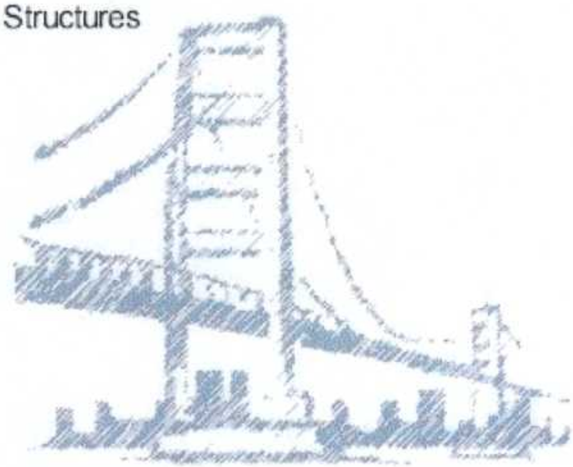
Construction Materials

Environmental

Geotechnical

Transportation

Structures



Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

Thumbnail Images
construction

BACK











Civil Engineering - A Bridge to the Future

Thumbnail Images

construction equipment

BACK

Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

Thumbnail Images

BACK
>>MORE

construction materials












Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

Thumbnail Images

construction materials

<<BACK

Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

Thumbnail Images
environmental

BACK
>>MORE











Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

Thumbnail Images

environmental

BACK

Civil Engineering - A Bridge to the Future

Thumbnail Images

geotechnical

BACK

>>MORE








Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

Thumbnail Images

geotechnical

<<BACK

>>MORE











Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

Thumbnail Images

geotechnical

<<BACK

>>MORE








Civil Engineering - A Bridge to the Future

<<BACK

Thumbnail Images

geotechnical









Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

Thumbnail Images

transportation

BACK

>>MORE








Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

Thumbnail Images

transportation

<<BACK

>>MORE








Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

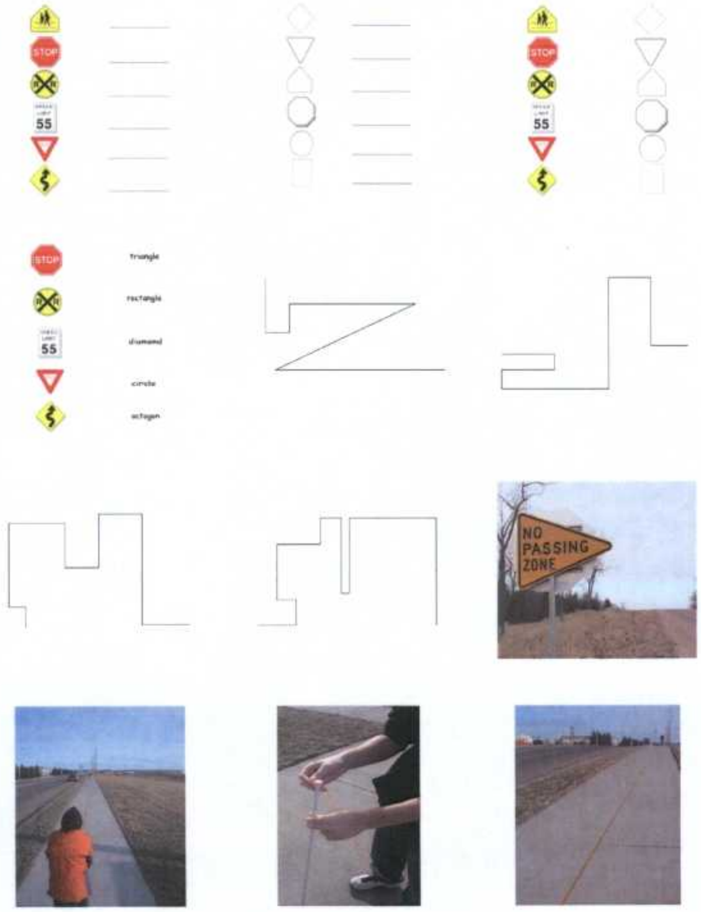
- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

Thumbnail Images

transportation

<<BACK



Civil Engineering - A Bridge to the Future

Thumbnail Images

structures

BACK

>>MORE












Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

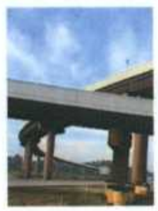
Thumbnail Images
structures

<<BACK
>>MORE












Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

Thumbnail Images

<<BACK

structures












Civil Engineering - A Bridge to the Future

Production Credits

This CD was produced through the efforts of the following individuals and organizations

University of Arkansas, Department of Civil Engineering

Dr. Suzette Burckhard, South Dakota State University

The Arkansas Highway and Transportation Department

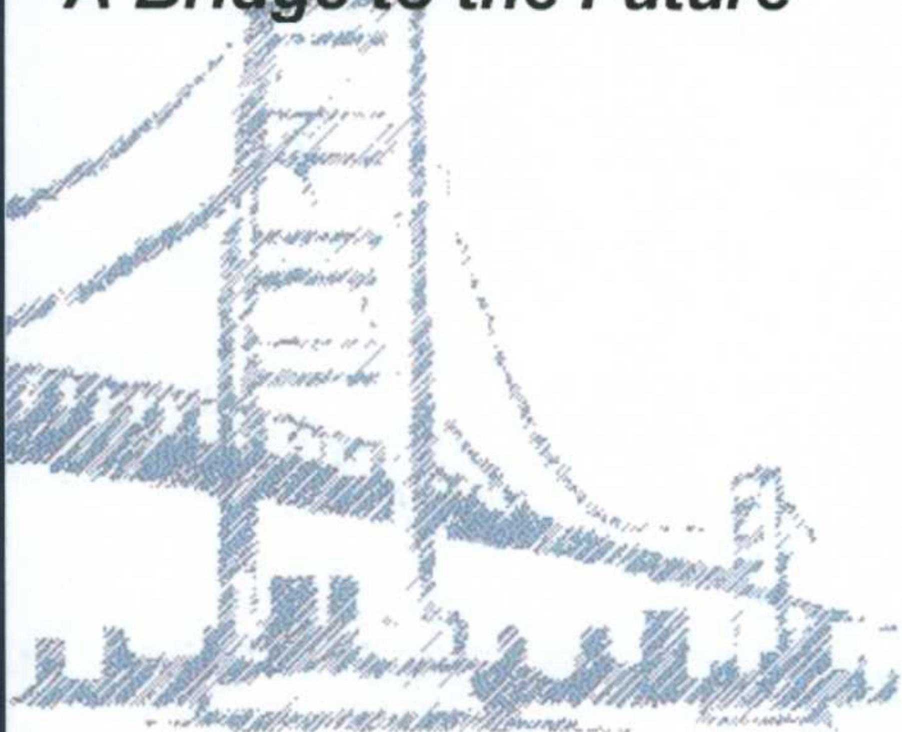
The Mack-Blackwell National Rural Transportation Study Center

The American Society of Civil Engineers

The Arkansas Chapter of ASCE

Ozark Film and Video

Civil Engineering
A Bridge to the Future



An Exploratory Career Curriculum for Teachers of K through 8th Grade

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

HOME

ENVIRONMENTAL engineering

K to 2nd Grade

Just Say No To Trash
Let's Ask Mikey, He'll Drink Anything
Let Me Breathe The Air

3rd to 5th Grade

You Wont Know What You've Got Till Its Gone
I'm Stuck On You
What? I Can't Hear You

6th to 8th Grade

Don't Run Off With My Soil !
Space, A Wasteful Frontier
Oil And Anything Don't Mix

Civil Engineering - A Bridge to the Future

JUST SAY NO TO TRASH

K-2 ENVIRONMENTAL **Lesson 1**

OVERVIEW

The effort to heighten the public's awareness regarding pollution started gaining widespread support in the late 1960's. While awareness and concern have continued to increase during the intervening years, so have the population and the per capita amount of trash being generated. Thus, the need to educate young people concerning pollution remains high.

It is important that children understand that there are many forms of pollution and that, in many cases, pollution can be easily prevented. This lesson plan formally introduces young children to the concept of pollution and affords them an opportunity to help prevent further pollution at their school.

OBJECTIVES

The students will be able to:

1. discuss at least four different types of pollution.
2. describe means for preventing pollution.
3. define and spell, as appropriate, the following vocabulary words.
    - pollution, air, water, waste, oil

MATERIALS

- Books
    - Oil Spill – by Melvin Berger
    - Where Does Pollution Come From? – by C. Vance Cast
    - Where Does the Garbage Go? – by Paul Showers
    - Pollution – Problems and Solutions – by National Wildlife Federation
    - Pollution – by Brian McIntyre
- Chart paper
- Markers

ACTIVITY

1. Ask the students to suggest a definition for the general term "pollution". Record the student's comments using the chart paper.
2. Pick one of the suggested books on pollution and read the book to the students.
3. Discuss some of the key points of the book. Revisit the students' previous thoughts and ideas on the concept of pollution. Compare the student's initial thoughts and ideas about pollution with those mentioned after reading the book.
4. If not previously addressed, discuss the fact that there are several different types of pollution, including air pollution, water pollution, waste water pollution, solid waste pollution, and noise pollution.
5. Write each of the above categories of pollution on different pieces of chart paper.
6. Take the thoughts and ideas expressed earlier by the students and categorize them into the different types of pollution. Also have the students offer more thoughts and ideas for each of the categories.
7. Now, have the student think of ways to prevent pollution. Try to identify a project where the students can help to stop the spread of pollution around their school.

LET'S ASK MIKEY, HE'LL DRINK ANYTHING

K-2 ENVIRONMENTAL **Lesson 2**

OVERVIEW

Even though the earth is covered mostly by water, the amount of water available for drinking, doing dishes, taking showers, and washing clothes is relatively limited. Given the population of the world and the available amount of clean water, it is necessary that polluted water be treated and reused. An important question to answer is, "How can you clean polluted water so that it is safe to use again?"

Modern cities construct water and sewage treatment plants so that their population can have an adequate supply of clean water. Treatment plants utilize a variety of techniques to remove contaminants, as well as add fluoride. One of the simplest means for cleaning water is through filtration. Polluted water can be passed through a series of filters in order to remove particles of various sizes. This approach will result in a sample of water which looks clean. However, small bacteria and pollutants can remain present in the water. Thus, other techniques must be employed to completely clean it.

OBJECTIVES

The students will be able to:

1. explain the concept of water pollution.
2. describe one technique for removing pollutants from a sample of contaminated water.
3. identify different sources and factors that contribute water pollution.
4. define and spell, as appropriate, the following vocabulary words.
    - pollution, air, water, waste, oil

MATERIALS

- Book: Oil Spill! by Melvin Berger
- 2 Glasses
- 2 Coffee Filters

- Funnel
- Tap water
- Spoon
- Soil (not potting soil)

ACTIVITY

1. Ask the students to tell you what they already know about water pollution. Questions that can prompt the students for input might include a) What causes water pollution?, b) Where does the pollution go?, c) What can happen to the earth if the pollution continues for many years?, and d) Is there any way to clean polluted water?
2. Place 2 empty glasses where all the students can see them. Pour tap water into one glass until it is about half full. See Figure 1.
3. Put a small amount (about one tablespoon) of soil into this glass of water. Stir the water-soil mixture until the mixture becomes cloudy. This is now polluted water. See Figure 2.
4. Place a funnel in the top of the second glass and then place the coffee filter into the funnel opening.
5. Pour the water-soil mixture through the funnel and coffee filter into the glass. See Figures 3 and 4.
6. Have the students pay close attention as the water-soil mixture passes through the filter. Highlight for the students any color change that occurs, as the mixture passes through the filter. Also, have them look at the filter to see if it has changed at all. They should discover that the water is not as cloudy (polluted) and that there is soil in the filter.
7. Move the funnel to the glass which initially held the water-soil mixture. Place a new filter in the funnel. Pass the polluted water mixture through the funnel a second time. Again, make note of any color changes in the water and residue in the filter. See Figure 5.
8. Discuss with the students why the water-soil mixture became clearer with each pass through the filter. Explain to them that the filter traps small particles which are floating in the water. Also explain that the particles that are trapped are larger than the openings in the filter.
9. Ask the students to identify objects that they may have at home which are like a filter. Examples might include a food sieve, a colander, a wash cloth, etc.
10. Consider repeating the experiment, but this time use food coloring to alter the appearance of the water. What happens when the colored water is

passed through a filter twice? Since the particles of food coloring are small compared to the openings in the filter, not as much material is captured by the filter. Thus, you need the right kind of filter for each kind of pollution.

11. Read the book Oil Spill ! by Melvin Berger.
12. After reading the book, discuss how oil and other materials affect water and the environment. Brainstorm with the students about how they can help stop water pollution in the environment.


Figure 1


Figure 2


Figure 3


Figure 4


Figure 5

LET ME BREATH THE AIR

K-2 ENVIRONMENTAL Lesson 3

OVERVIEW

Air pollution is arguably the most recognized form of pollution. This is because it can be experienced almost on a daily basis. If you live in areas such as Los Angles, Chicago, New York, and Atlanta the haze on the horizon is a daily reminder of the presence of air pollution. While the discharge from cooling towers is no longer the environmental threat it once was, many individuals still associate pollution with the plumes of smoke emanating from such a tower. Cigarette smoke and automotive exhaust are very common forms of air pollution. Unfortunately, air pollution can not always be detected by visual means. What might appear as harmless could actually be producing a large, collective, volume of air pollution.

OBJECTIVES

The students will be able to:

1. explain that there are many sources of air pollution.
2. explain that while air might look clean, it may actually be polluted.
3. define and spell, as appropriate, the following vocabulary words.
    - pollution, air, water, waste, oil

MATERIALS

- 1 Candle
- Matches
- Notebook Paper
- Chart paper
- Markers

ACTIVITY

1. Ask the students to tell you what they already know about air pollution. Questions that can prompt the students for input might include a) What causes air pollution?, b) What does air pollution look and smell like?, c) Can air pollution make you feel sick? Record the student's response on a piece of chart paper.
2. Explain that you are going to demonstrate one type of air pollution. **Make sure that the students understand that they should never repeat this experiment at home or anywhere else**.
3. Explain to the students that you are going to light a candle and hold a piece of paper over the flame, but not close enough for it to burn. Ask the students what they believe will happen to the paper.
4. List their remarks on the chart paper.
5. Now light the candle and run a piece of paper over the flame. Hold the paper close enough to the candle to catch the "pollution", but not close enough to catch the paper on fire! See Figure 1.
6. Show the students the piece of paper and ask them what they see on the paper. Tell them that the color on the paper is an example of air pollution. See Figure 2.
7. Have the students compare what happened on the paper to what they predicted would happen.
8. Prepare a list of other possible sources of air pollution. Ask the students to pick the sources they think produce the most pollution.
9. Have the students draw a picture of what they think the earth might look like if the air is not kept clean.

Figure 1

Figure 2

YOU WON'T KNOW WHAT YOU'VE GOT TILL ITS GONE

3-5 ENVIRONMENTAL **Lesson 1**

OVERVIEW

Modern cities construct water and sewage treatment plants so that their population can have an adequate supply of clean, potable water. Treatment plants utilize a variety of techniques to remove contaminants from water. One of the simplest means for cleaning water is through filtration. Polluted water can be passed through a series of filters in order to remove particles of various sizes. While the result is a sample of water which appears to be clean, small bacteria and pollutants still remain in the water. Thus, other processes must be employed to completely clean the water.

When filtration is used as a step in cleaning water, the question "How much of the pollutant will the process remove?" is soon to be asked. Why? Because the effectiveness of the process is as important as the process itself. Therefore, the Environmental Protection Agency, EPA, places limits on how much of a pollutant can be present in drinking water. The amount can described in parts per million (ppm), milligrams per liter (mg/L), or other similar units. Large values mean more of the pollutant in the water. Smaller numbers mean less of the pollutant, but generally require a high cost to achieve.

OBJECTIVES

The students will be able to:

1. describe one technique for removing pollutants from a sample of contaminated water.
2. determine the amount of pollutant removed from a sample of contaminated water.
3. define and spell, as appropriate, the following vocabulary words.
   - pollution, environment

MATERIALS

- Books:
  Oil Spill! by Melvin Berger

<u>Where Does Pollution Come From?</u> by C. Vance Cast
<u>Air Pollution</u> by Rhonda Lucas
<u>Pollution</u> by Keith Bardon
<u>Pollution and Waste: Environmental Facts and Experiments</u> by R.Harlow

- 2 Glasses per group
- 2 Coffee Filters per group
- 1 Funnel per group
- Tap water
- 1 Spoon per group
- Soil (not potting soil)
- Scale for measuring small weights (0.1 g scale preferred, 1g scale acceptable, 10g scale will not be acceptable). See Figures 1 and 2 for images of appropriate scales.

ACTIVITY

1. Divide the class into small groups of a manageable size.
2. Provide each group with 2 glasses, 2 filters, 1 funnel, 1 spoon, water, soil.
3. Have each group measure the weight of about 2 tablespoons of soil. Find this weight to the nearest 0.1 gram (or 1.0 gram).
4. Find the weight of one glass to the nearest 1 gram.
5. Soak the coffee filter in water for about 30 seconds. Take the filter out of the water and shake off any excess. Determine the weight of the dampened filter to the nearest 0.1 gram.

   The filter must be dampened first in order to cancel the weight of the polluted water. If the filter is not dampened, the weight of the polluted water will affect the final weights.
6. Pour tap water into the second glass until its about half full. See Figure 3.
7. Put the soil into this glass of water. Stir the water-soil mixture until the mixture becomes cloudy. This is now polluted water. See Figure 4.
8. Place the funnel in the top of the second glass.
9. Pour the water-soil mixture through the funnel and coffee filter into the glass. See Figures 5 and 6.
10. Have the students pay close attention as the water-soil mixture passes through the filter. Have the students note any color change that occurs, as the mixture passes through the filter. They should discover that the water is not as cloudy (polluted) and that there is soil in the filter.

11. Remove the filter from the funnel and place it on the scale. Find the weight of the filter/soil to the nearest 0.1 gram.
12. Find the weight of the glass containing the polluted water.
13. Determine the weight of water in the glass by subtracting the weight of the empty glass from that of the filled glass. Determine the weight of soil in the filter by subtracting the weight of the damp filter from the filter/soil combination.
14. Divide the weight of the soil in the filter by the weight of the polluted water in the glass. This ratio is an indicator of the efficiency of the filtering system.
15. Consider repeating the experiment, but this time use food coloring to alter the appearance of the water. What happens when the colored water is passed through a filter?

    Since the particles of food coloring are small compared to the openings in the filter, not as much material is captured by the filter. Thus, you need the right kind of filter for each kind of pollution.

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

I'M STUCK ON YOU

3-5 ENVIRONMENTAL Lesson 2

OVERVIEW

From time to time we come across a very distinctive ray of light coming into a room in our home, place of work, or school. Depending on the angle at which you view the ray of light, you can see tiny particles floating in the air. This might cause you to wonder about the make-up and source of these particles. Your thoughts might progress to concerns about the potential health risks associate with the particles. On a broader scale, you might begin to wonder about the air quality throughout your city.

Although government regulations have contributed to an improvement in air quality for portions of the world, air pollution remains a serious global issue. Part of the effort to improve air quality involves identifying the pollutants in the air, as well as their source. With this information it is possible to institute policies and procedures to control the emission of pollutants.

OBJECTIVES

The students will be able to:

1. identify common sources of air pollution.
2. observe air pollution as it occurs in a classroom setting.
3. define and spell, as appropriate, the following vocabulary words.
    - pollution, pollutants, environment, particles, source, quality

MATERIALS

- Book: Air Pollution, by Rhonda Lucas, Lucas Donald
- Box fan
- Tack cloth (as used in wood working)
- Duct tape
- Chart paper

ACTIVITY

1. Have the students take turns reading portions of the book Air Pollution aloud. Select two or three of the main points from the book to discuss with the class.
2. Assist the students with taping the tack cloth to the intake side of the box fan.
3. Position the fan in the classroom so that it is out of the traffic flow and so that it does not disturb the class while it is turned on. Turn the fan on to its lowest setting. Allow the fan to run for the majority of the day.
4. At the desired time, turn off the fan and remove the tack cloth. Have the students categorize and document the items caught on the tack cloth. Record their findings on a piece of chart paper for all to see.

   Depending on the environment and duration the fan is left on, it is possible that there will be only a few particles found on the tack cloth.
5. Discuss with the students what they observed on the cloth. Try to assess the source of the material on the cloth. How much of the materials originated in the class room? From outside the classroom?
6. This experiment can be repeated in a variety of ways. Begin by placing new tack cloth on the fan.
   - run the fan for a longer period of time, say overnight
   - sweep the dust off of the floor toward the intake side of the fan
   - place the fan in a different part of the school
   - place the fan in a classroom window to draw material from the outside, or place the fan outside.
7. With each experiment, categorize and document the items caught on the tack cloth.
8. When all versions of the experiment have been completed, have the class create a poster to present information on the different materials collected on the tack cloth.

WHAT? I CAN'T HEAR YOU

3-5 ENVIRONMENTAL **Lesson 3**

OVERVIEW

It is often forgotten that pollution is not limited to the air, water, or land. There is also what is termed "Noise" and "Sight" pollution. Noise pollution refers to the type and volume of sounds which can have an adverse affect on our hearing. Problems related to noise include hearing loss, stress, high blood pressure, sleep loss, distraction and lost productivity, and a general reduction in the quality of life and opportunities for tranquility. Sight pollution refers to all the signs, images, and colors that we see and which can over stimulate our senses.

While Noise and Sight pollution are generally not thought to be as serious as air, water, or solid waste pollution, both can affect one's quality of life. Noise pollution can increase the need for a hearing aide where as Sight pollution can distract us while driving which could contribute to an accident. Limiting both Noise and Sight pollution can only enhance the beauty of the world around us.

OBJECTIVES

The students will be able to:

1. identify sources of noise and sight pollution.
2. formulate a plan to limit the amount of noise and sight pollution we are exposed to.
3. define and spell, as appropriate, the following vocabulary words.
    - noise, sight, pollution, environment, source, quality

MATERIALS

- Chart paper
- Notebook paper

ACTIVITY

1. Have each student identify at least five examples of noise pollution and five examples of sight pollution in the community. The students can only document examples where the source is within 5 miles of their home. This should help bring variety to the examples cited by the students. Have the students record the following for each example.
   - description, or name, for the noise (sight)
   - location where the noise (sight) was observed
   - location where the noise originated from
   - the relative volume of the noise, as compared to a standard such as a commercial on TV, a car engine when parked in a driveway, a song on the radio, or other example.
   - the relative level of stimulation from the sight, as compared to a standard such as a traffic sign (stop sign), a body of water, the exterior of the school, or other example.
2. At the appointed class time, have each student present their list in turn. Record this information on the chart paper, noting any duplicate entries. Look for trends in the examples so that the collected date can be categorized in a simple manner. Typical categories might be based on
   - volume of the noise
   - source of the noise (image)
   - distance between source of noise and location where heard
   - greatest distance from which the image can be seen
   - the degree of stimulation from the sight
   - etc.
3. Select one category of noise and one category of image and devise a plan to reduce the adverse impact of each. For example, consider noises which can be heard over long distances. What might be done so that a noise could not travel over a great distance, thus affecting fewer people. One solution is to construct sound barriers, as can be seen along urban highways.

DON'T RUN OFF WITH MY SOIL!

6-8 ENVIRONMENTAL Lesson 1

OVERVIEW

As you travel within your city, or on an interstate highway to another city, you will likely come upon a number of construction sites. If you stop and take a close look at a construction site, you will likely find bails of hay, or straw, placed around the site. You will also find long lengths of fabric, which are short in height, being held in place by wooden stakes. See Figure 1. Soon you will find yourself contemplating the purpose for having hay and fabric at a construction site.

When water runs across, and off, a construction site it will pick up and carry with it particles of soil and other solid material off the ground. If we assume that this water is initially clean, then by definition the runoff would be polluted. Because construction sites can cover large areas, and be present for extended periods of time, it is necessary to manage the flow of any polluted surface water runoff. If this water is not controlled, it will eventually reach a stream, pond, or other body of water thereby polluting it.

When a construction site is cleared, the grass, trees, and plants that once provided natural control over surface runoff are lost. Therefore, hay and fabric are installed by the contractor for the purpose of managing any runoff. What once was controlled by Mother Nature must now be controlled by artificial means.

OBJECTIVES

The students will be able to:

1. summarize the need to control surface water runoff at a construction site.
2. describe the role that vegetation, such as grass, trees, bushes, etc. has on controlling runoff.
3. site other examples where surface water runoff would be expected to, or did, change subsequent to the completion of construction.
4. define the following vocabulary words.
    - construction site, pollution, erosion, surface water runoff, soil, dirt

MATERIALS

- 2 flat, single use, aluminum pans, 13 in. by 9 in. by 2 in. tall.
- A small nail and hammer
- 2 small pieces of Duct tape
- A large of potting soil
- 1/2 pounds of grass seed commonly used in your area
- A container that is at least 3 cups in volume
- Water
- 1 small book, or other item, that is roughly the same width as the pan and about 1 inch thick
- A group of small jars, such as baby food jars, the number depending on the duration of the activity
- A small spray bottle

ACTIVITY

This activity can involve the entire class or the students can be divided up into groups of three to five. Completion of this activity will take place over a period of several weeks. Samples of runoff water will be taken each week and stored with the samples previously taken. Near the conclusion of this activity, all samples can be collected, examined, and then disposed of.

1. Using the nail and hammer, create a hole in the bottom of each pan near a corner. See Figure 2. Place a small piece of Duct tape, on the outside of the pans, over this hole as shown in Figure 3.
2. Starting at the end of the pans opposite from where the holes were just made, add and lightly compact the potting soil with your hand. Continue to add, and lightly compact, the soil until the layer of soil is about 2 inches thick. Make certain that the soil has a fairly uniform thickness across the pans.
3. At the end of the pans with the hole, be sure to leave a space about 2 inches wide that extends across the entire width of the pan. This space will be referred to as the "trough". See Figure 4.
4. Following the manufacturer's instructions, add grass seed to one of the two pans of soil.
5. Place the book, or other item, under the aluminum pan at the end opposite of where the hole is located (see Step 1). See Figure 4.

6. Carefully pour 2 cups of water across each pan of soil as seen in Figure 5. Do not allow the water to create a hole in the soil as water is poured in to the pan. Rather, move the container as the water is poured. Wait about 30 minutes as the water moves across the inclined surface of soil and into the trough.
7. Position each pan so that the Duct taped hole is over the edge of a table or counter top. Hold a small jar under the hole and slowly remove the Duct tape. Allow the polluted water to be collected in the jar. See Figure 6.
8. Mark the jar with the date the sample was obtained, as well as whether the sample is from the pan with, or without, the grass seed. Store the jar in a convenient location. Repeat this step for the other pan.
9. Record the initial appearance of any grass growth. Also, measure the height of a few blades of grass. Determine an average blade length and record this value.
10. Move the pans to a location where they can receive sunlight, but will not "bake" due to excessive heat. Use a spray bottle to moisten the surface of the soil each day.
11. Repeat Steps 5 through 10 once a week for the duration of this activity.
12. Near the conclusion of this activity, have the groups gather their water samples together. The groups should prepare written reports which, in general, comment on the appearance of the water samples. The groups should prepare specific comments on changes in appearance over time, as well as similarities and differences in the water from the two pans.
13. The groups' reports should also comment on the growth of any grass. Items that might be mentioned, along with the measured length, include density of growth (all over or isolated, long or short, etc.), and the impact of grass growth on the magnitude of runoff.
14. Have the students end their reports with an assessment of the impact that vegetation, in this case grass, can have on the amount of runoff and the extent to which the runoff is polluted.

Figure 1

Figure 2

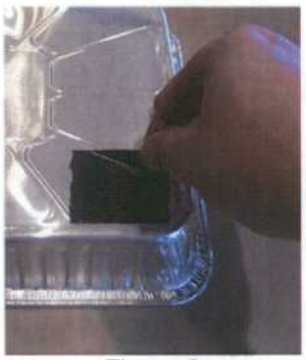


Figure 3

Figure 4

Figure 5

Figure 6

SPACE, A WASTEFUL FRONTIER

6-8 ENVIRONMENTAL **Lesson 2**

OVERVIEW

What happens to the solid waste that a family generates each week? It goes in the garbage, right? But, what happens to it after that? Many cities use landfills to dispose of the waste created by its citizens. At a landfill, waste is first deposited on to an existing pile of material. The new waste is compacted and spread out using large pieces of equipment such as bulldozers. Soil is layered on top of the waste material, spread out and compacted as well. Thus, a landfill consists of layers of waste and soil. At some point in time the landfill is considered to be filled, and thus is closed. Then, a new landfill, or some other approach, must be used to dispose of the cities' continuing flow of solid waste.

What are the factors which influence the "life" of a landfill? Obvious factors include the original size of the landfill area, the population of the city, the type of waste permitted to be disposed, and the volume of waste generated by a household. Of those listed, the latter is a factor that each individual can control to a certain extent. However, the volume of waste a household generates is due, at least in part, to the packaging that products come in. For example, a game cartridge for a handheld game system comes in a box which is roughly 30 times larger than the game itself. In other words, you could put 30 games in the box that just one game is sold in. Why all the excess space, advertising and user manuals? Another example is a soda can. When full it holds 12 ounces of liquid. When empty, the can occupies the same volume but contains nothing. So it would appear that if we can reduce the VOLUME of our waste then we can prolong the useful life of a landfill.

OBJECTIVES

The students will be able to:

1. list factors which influence the useful lifetime of a landfill.
2. identify products whose packaging has a far greater volume than the product contained therein.
3. define the following vocabulary words.
   - compaction, dispose, deposited, population, landfill, volume, density

MATERIALS

- 2 "dish barrel" sized moving boxes
- Measuring tape
- Calculator
- Bathroom scale
- "Clean" garbage

ACTIVITY

In this activity, the students will bring garbage from home to place in boxes, which represent landfills. It is important that the items which students bring to school be clean and dry. This is not a problem for boxes, but is an issue for canned products, milk cartons, juice bottles, etc. This activity also requires students to make volume calculations. Therefore, this activity could be combined with math principles on volume and density.

1. Prepare a list of garbage items which the students are to bring to school. Have a range of the types and size of items on the list. Be sure to inform the students that they must clean the garbage as needed and to bring the items to school in the un-compacted state.
2. Place the two dish barrel boxes in a convenient location within the classroom. Label one box "Compacted" and one "Un-compacted".
3. As students bring items from home, have them determine an approximate volume for each by measuring the height, width, and depth of the piece of garbage.
4. When adding an item to one landfill box, make sure that a like item goes into the other box. Thus, at any point in time, the number of pieces and type of garbage should be the same in both boxes. Keep count of the number of any one type of garbage item, as well as the overall total number of items, in the landfill boxes.
5. Determine how many pieces of un-compacted garbage it takes to fill one of the dish barrel boxes. Continue to add items to the compacted landfill box until it reaches a predetermined level. It will take too many pieces of garbage to completely fill the compacted landfill box.
6. Based on the number of items needed to fill the compacted landfill box to the designated level, have the students compute an estimate of the total number of pieces of garbage needed to fill the entire box.

7. While the students are looking for garbage items that are on the list they have been provided, have them also look for examples where the product is much smaller than the container it is sold in. In addition, have them look for examples of where the size of a package has been reduced to minimize waste (i.e. newer computer software boxes).
8. Consider giving out prizes to students who find 1) the package which is the greatest number of times larger than the actual item inside, 2) the best examples of redesigned packaging to reduce waste, or 3) the package with the greatest reduction in volume when it is compacted.
9. Have the students research the average number of pounds of garbage generated by an individual in a calendar year. Using data based on the compacted landfill box, have the students compute the volume of garbage generated, on average, in a calendar year by an individual.

OIL AND ANYTHING DON'T MIX

6 -8 ENVIRONMENTAL **Lesson 3**

OVERVIEW

In March of 1989 the Exxon Valdez, an oil tanker for the Exxon Corporation, ran aground in Prince William Sound, Alaska. The ship proceeded to spill 11 million gallons of oil (roughly the equivalent of 125 Olympic-sized swimming pools) into the sound. It took over 4 years and $2.1 billion dollars to complete the major portion of the clean-up effort. This incident remains one of the worst environmental disasters to have ever occurred.

What makes an oil spill such a devastating disaster is the fact that it is very difficult to clean oil off *anything*. Oil and water, oil and soil, oil and animals, oil and plants, oil and anything just don't mix. Think of how much more difficult it is to clean up after using oil-based paint as opposed to latex paint. Several different approaches were used in the Valdez spill, some worked and some did not. While we never want disasters such as the Valdez spill to occur, lessons are learned from these events which educate us about how to prevent and resolve such problems.

For details regarding the Valdez spill, refer to the following website, then click on "Oil Spill Facts".

http://www.evostc.state.ak.us

OBJECTIVES

The students will be able to:

1. discuss the facts of the Valdez oil spill.
2. identify techniques which will/will not remove household oils from water, feathers, and plant leaves.
3. create a table of Oil Type vs. Cleaning Technique to present which techniques are effective in separating and cleaning an oil spill.
4. define the following vocabulary words
   - environment, corporation, equivalent, devastating, viscosity

MATERIALS

- Several 9 inch round aluminum single use pie pans
- Small bottles of vegetable oil, motor oil, baby oil (with a food coloring added for visibility), or castor oil
- A measuring cup to add water to the pie pans
- Several small paper cups to hold samples of the various oils and sand
- A box of plastic spoons for adding oil products to the water
- A bottle of food coloring to help distinguish a clear oil from the water
- A strainer and coffee filters for collecting and removing oil from the pans
- Kitty litter, Dawn dish detergent, paper towels, 409 or other similar household cleaner, and any other cleaning items you or the students wish to try
- Assorted small feathers, small plant leaves, pieces of fabric, clean sand, and other items of your choosing

ACTIVITY

1. Divide the class into small groups if you wish. This is not absolutely necessary.
2. Give each group/individual a supply of pie pans, cups of oils, plastic spoons, a measuring cup for water, and various feathers, leaves, cups of sand, etc.
3. Also, give each group/individual a strainer and several filters.
4. You may choose to develop a list of oils, added items, and cleaning techniques for the students to investigate. If so, give each student/group a list of combinations to test.
5. Have the students place 1 to 3 cups of water into a pie pan.
6. Using the plastic spoons, have the students add differing amounts of different oils to the pie pans. You may want to add food coloring to the oil to help distinguish it from the water. The students should work with one pan and one oil at a time.
7. Next, per your instructions, have the students add feathers, leaves and sand to the oil and water mixture. Allow these items to sit in the mixture for several minutes.

8. Using the kitty litter and/or cleaning supplies, have the students begin their efforts to remove the oil from the water and clean the items they placed in the pan.
9. For each combination of oil, materials, and cleaning techniques record the level of success or failure experienced.
10. Separate the students into 2 or 3 groups. Have the groups create a table which presents the findings from their respective research efforts. Allow the format of the posters to be of the students choosing.
11. Have each group make a presentation to the rest of the class explaining what the students in their group discovered through their testing.

STRUCTURAL engineering

K to 2nd Grade

What's In A Name
That Muffin Is Hard As A Rock
Humpty Dumpty Sat On A Wall

3rd to 5th Grade

Push, Pull, Or Drag It In
Sponge Beam Square Shaped
The Bridges Of Paper County

6th to 8th Grade

I'm Stuck And Can't Get Down !!
Is That Cement Or Concrete?
How Dense Can You Be?

Civil Engineering - A Bridge to the Future

WHAT'S IN A NAME

K-2 STRUCTURES **Lesson 1**

OVERVIEW

Civil engineers are probably best known as the profession responsible for designing and constructing bridges, roads, dams, buildings and other structures. When a structure is to be built it is intended that it serve a very specific purpose. For example, buildings provide shelter while bridges provide a means to cross an obstacle. The purpose of the structure influences many aspects of the design and construction process. Thus, one of the first pieces of information a civil engineer wants to know is the purpose of the structure. Knowing the purpose, the engineer can properly categorize the structure and then proceed with an appropriate, useful, and safe design.

OBJECTIVES

The students will be able to:

1. describe common structures such as buildings, bridges, and dams.
2. categorize structures according to their use.
3. define and spell, as appropriate, the following vocabulary words.
    - building, bridge, dam, stadium, tower

MATERIALS

- Books about buildings, bridges, dams, and towers from the Book List on the CD
- Pictures of buildings, bridges, dams, towers, and the machines that are used to build these structures (bulldozers, concrete mixers, backhoes, etc) from the image file on the CD
- Chart paper

ACTIVITY

1. Ask the students to name different types of structures that they are familiar with. Discuss the purpose of these structures. With their purpose identified, categorize the structures using the following definitions.

Bridge	*a structure to connect two pieces of land separated by water or a valley, or to allow for travel over another roadway*
Dam	*a structure that retains water. The water may be for recreation, a water supply for a city, or to provide an environment for wildlife*
Building	*structure that provides shelter for people and objects.*
Stadium	*a structure where sporting events are held.*
Tower	*a structure for placing antennas and communication equipment above the ground, or to allow for someone to see around an obstacle such as a forest of trees*

2. Make a collage of structures with the pictures provided by the students and vocabulary words listed above. The pictures can be drawings, taken from newspapers, taken from magazines, photographs, and the like.

3. Have the students draw a picture of a structure which reminds them of one of the most fun outings they ever had. This could be a swimming pool, a sports stadium, a home, an amusement ride, etc.

THAT MUFFIN IS HARD AS A ROCK

K-2 STRUCTURES **Lesson 2**

OVERVIEW

Structures are generally built from one or more of the following materials: concrete, steel, wood, or masonry block. Of these materials, concrete is the most widely used. In fact, there are places in the world that have no access to steel or wood and thus use only concrete or block for construction. Note that masonry block is fabricated from the same materials used to produce concrete.

Another aspect of concrete which makes it the material of choice is that, given the proper ingredients, anyone can make it. Today, you can buy pre-mixed bags of the dry ingredients in concrete from a local home center. Then, just like with some cake mixes, all you have to do is add water and stir. Working with steel and wood is not this easy. Both of these materials require the use of special, and in most cases power, tools. This restricts their use in many parts of the world.

Concrete can be used for nearly any type of structure. This includes, home foundations and basement walls, driveways and sidewalks, roads and bridge decks, swimming pools, and much more. Concrete is a very versatile and durable construction material.

OBJECTIVES

The students will be able to:

1. identify the basic ingredients of concrete.
2. explain the process needed to mix concrete.
3. identify different uses for concrete.
4. define and spell, as appropriate, the following vocabulary words.
    - concrete, cement, sand, water, cure

MATERIALS

- Book - Building with Concrete by The Aberdeen Group

- Muffin pans, one muffin per student
- Mixing bowl and spoon
- Metal rod
- 3 containers – one for water, one for sand, one for cement
- Water
- Sand (obtained from a home center)
- Cement (obtained from a home center)
- Rubber gloves

ACTIVITY

Before beginning this activity it will be necessary to set up stations around the room. Each station should have a muffin pan, rubber gloves for each student, a mixing bowl, a mixing spoon, and a metal rod. Have another area near by with the containers holding sand, water, and cement.

When mixing the concrete, have the students put two parts sand and one part cement into the mixing bowl. Once the sand and cement are mixed together have the students add water into the mixture until it is the consistency of a cake batter.

1. Show the students a piece of concrete (a finished concrete muffin) and ask them for ideas of what is in concrete and how it is made.

   Note that cement and concrete are not the same things. Cement is an ingredient of concrete.

2. Show the students the different ingredients (less rocks) which are typically used to make concrete and tell that they are going to make concrete muffins.
3. Divide the class into small groups of a manageable size. Have each group go to one of the existing stations.
4. Have a student from each group get the containers holding sand, water, and cement from that station.
5. Demonstrate the process of putting some sand, water, and cement into the mixing bowl. Instruct the students to take turns pouring and stirring the contents.

   Make sure that each student wears a pair of rubber gloves throughout the entire project.

6. Assist the groups in placing the concrete mixture into each of the muffin holes. A large spoon works well for this.
7. Once the muffin holes are filled, push the metal rod into each muffin several times to remove any trapped air.
8. Lightly tap the muffin tins on a table or on the floor to level the mixture.
9. Allow the muffins to cure overnight before removing the concrete from the pans.
10. The students may paint or decorate the muffins once they have cured.
11. Be sure to clean all pans, spoons, rods, etc so that the concrete will not harden on the equipment.
12. Have the students come back together and ask them for examples of structures that are made from concrete.
13. Read the book, Building with Concrete. Discuss a few of the main points from the book.

Figure 1

Figure 2

Figure 3

HUMPTY DUMPTY SAT ON A WALL

K-2 STRUCTURES **Lesson 3**

OVERVIEW

It is fairly common practice to construct the walls in a building, particularly in schools, using masonry blocks. These blocks are stacked, one on top of the other, from floor to ceiling. Masonry mortar is used to fasten, or bond, the blocks together. The final product is a strong, stable wall which separates rooms in a building and provides protection from the outside environment.

A key part of building a wall is making sure that the masonry blocks are securely fastened to each other. If not, as the students will discover, the wall will easily come crashing down. The proper means for fastening two building components together will be a function of the construction materials being used. As noted above, mortar is used with masonry blocks.

OBJECTIVES

The students will be able to:

1. understand the importance of using the correct materials in construction.
2. evaluate differing designs in order to determine the best design for constructing a wall.
3. define and spell, as appropriate, the following vocabulary words.
    - wall, glue, nails, screws, mortar, blocks, strength

MATERIALS

- Sugar cubes (50 for each student)
- Glue

ACTIVITY

1. Ask the students for their thoughts on how a home is built. More specifically, how pieces of wood, brick, and metal are fastened to each other. Likely responses might include nails, screws, glue, welding, or

cement. Continue this discuss by asking why the pieces of a home need to be securely fastened together.

Fasteners are used to keep the structure from falling down.

2. Have the students build two simple wall structures in order to demonstrate the need to fasten pieces of a structure together
3. Give each student approximately 32 sugar cubes. Have them stack the cube in order to build a wall. Suggest that the wall be about 8 cubes long and 4 cubes high. See Figure 1.
4. After the students have built their wall, have them push on the wall to test its strength. See Figure 2. Discuss what happens to the wall after being pushed on.
5. Ask the students to propose ways in which the sugar cubes could be fastened together to make the wall stronger. Possible suggestions might include using glue, tape, pins, string, and others.
6. Now have the students rebuild the wall. However, this time have them use glue to fasten the cubes to each other. Allow the glue to dry before testing the wall for its strength.
7. Have the students push on the wall as they had done in Step 4. Ask the students to compare how the two walls responded to being pushed on.
8. Provide each student with about 18 more sugar cubes. Ask them to glue these cubes to their current wall so that it will not tip over. Once each student has completed this task, ask a few students to explain the reasoning behind their designs.

Figure 1

Figure 2

Figure 3

PUSH, PULL OR DRAG IT IN

3-5 STRUCTURES **Lesson 1**

OVERVIEW

The next time the opportunity arises, carefully examine the type of materials used to construct a building, bridge, dam, roadway, tower, or other structure. You will discover that structures (buildings, bridges, etc) are typically built from concrete, steel, wood, or some combination of the three. City streets and highways are constructed using concrete or asphalt. Why is it that asphalt is used in highways but not for the bridges on a highway. Why is steel used in a building but not for a city street? Why are long bridges built from concrete and steel, but not with wood? The answer relates to the ability of a material to resist an applied force. Asphalt has very little resistance when it is pulled apart: a type of force that is very common in a bridge. Steel is too expensive and heavy to be used as a roadway, and wood can not resist the tendency to bend when used over long distances.

In order to determine how a material will respond to a certain type of load, civil engineers will test many samples to determine if there is a common result or a general trend. This information is then provided to a structural engineer who uses it to properly dimension a column or beam in a structure. Without the information gained from testing, the construction of a structure would be a trial and error process. No one would want to be on the error side of this experiment.

Three common forces that a structure might be subjected to are TENSION, COMPRESSION, and TORSION. Tension occurs when the ends of a piece of material are pulled apart. Compression occurs when the ends are pushed together. Torsion is the action of twisting the ends in opposite directions.

OBJECTIVES

The students will be able to:

1. understand the concept of a tension, compression, and torsion force
2. make a prediction and evaluate the accuracy of the prediction following an experiment
3. define and spell, as appropriate, the following vocabulary words
    - tension, compression, torsion, structure, construction, highway, concrete, steel, wood

MATERIALS

- Paper, string, yarn, tongue depressors, clay or play-doh, cleaning sponges, erasers, paper towel or toilet paper tubes, pencils, aluminum foil, straws, strips of cloth, or ceramic tiles.
- A piece of rope about 48 inches long
- A broom handle, or other similar length of ridged material
- Pencil, pen, or marker
- Chart paper
- A worksheet with rating scale and table to record results

ACTIVITY

1. Have two students come to the front of the class to assist with a demonstration. Have each student take one end of the piece of rope.
2. First, have the students PULL on their ends of the rope. Discuss what happens to the rope when it is PULLED.
3. Next, have them PUSH the rope toward each other. Discuss what happens to the rope when it is PUSHED together.
4. Lastly, have each student TWIST their end of the rope in a manner similar to using a screw driver. Again, discuss the result of TWISTING the rope.
5. Now, repeat Steps 1 through 4 with two new students and a broom handle instead of a rope.
6. Introduce the students to the terms TENSION - pulling, COMPRESSION - pushing, and TORSION - twisting.
7. On the chart paper, create a table with ROWS titled tension, compression, and torsion. Title the COLUMNS rope and broom. In the cells of the table, identify whether the rope/broom was STRONG or WEAK in tension, compression, and torsion. Note the differences between the two materials.
8. Now, divide the class into small groups of a manageable size.
9. Choose six to eight different items, such as those identified in the materials list, and provide a set for each group of students.
10. The groups will test each material to determine its ability to resist tension, compression, and torsion. Give each group a worksheet to record their results. See Table 1.

11. Before testing the materials, have the groups predict how well each material will resist tension, compression and torsion. Use the rating scale provided with Table 1. The groups are to record their predictions on the worksheet in Table 1.

12. The groups then test each of the materials and record the actual outcomes. If possible, have the students pull, push, and twist (each end in the opposite direction) each material until it breaks. Depending on the materials you select, it may be necessary for the students to use eye protection.

13. Use the rating scale that is provided on the worksheet to assess how each material resisted the three different forces.

14. After testing the materials and recording the results, have the students evaluate which of the materials performed as predicted and which did not. Also, have the students identify which materials were strongest/weakest in tension, compression, and torsion. Was any material strong or weak in all three cases?

    Materials strong in TENSION
    string, yarn, pipe cleaners, tongue depressors, ceramic tile, cardboard, straws, cloth, rubber band (strong, but very flexible), rubber eraser, paper towel tubes, and pencils.

    Materials strong in COMPRESSION
    tongue depressors, clay (limited), ceramic tile, rubber eraser, paper towel tubes (limited), and pencils.

    Materials strong in TORSION
    ceramic tile, rubber eraser (limited), paper towel tubes, and pencils.

15. After the groups have tested all of their materials, have them return to the large group and discuss the results of their tests. This discussion can be enhanced if there is some overlap in the materials that each group tested. However, make sure that each group also has some unique materials.

16. As a group, discuss which of the materials tested would be well suited for use in building structures such as foundations, buildings, bridges, and other similar projects.

Table 1. Worksheet for Recording Data

MATERIAL	TENSION		COMPRESSION		TORSION	
	Prediction	Result	Prediction	Result	Prediction	Result

RATING SCALE

Weak	Can withstand hardly any force.
Fair	Can withstand some force.
Good	Can withstand a lot of force.
Strong	Cannot be broken.

SPONGE BEAM SQUARE SHAPED

3-5 STRUCTURES **Lesson 2**

OVERVIEW

With respect to a building, a beam is a horizontal structural element that connects two columns. Columns are the vertical members. In a bridge, beams connect successive pier supports. Beams in a bridge are often called "girders".

When a group of vertical columns is put together and connected with a group of horizontal beams, a building frame is created. A building frame looks something like a jungle gym. The beams are supported by the columns. The floor is supported by the beams. The weight of people, furniture, and equipment is supported by the floor.

In a framed building the loads placed on the floors cause the beams to bend. The columns are then compressed by the beams. The frames of buildings work together because the loads on the buildings develop compression in the columns and both compression and tension in the beams. When a material is bent, both compression and tension occur.

Thus, beams are a very important part of a building or bridge structure. Without them it would be much more difficult and costly to build floors, ceilings, and bridge decks.

OBJECTIVES

The students will be able to:

1. explain how a beam resists the forces of people, furniture, equipment, or vehicles.
2. explain how tension and compression forces develop within a beam.
3. define and spell, as appropriate, the following vocabulary words
    - beam, column, horizontal, vertical, neutral axis, cantilever, load, compression, tension, stiff materials, steel, concrete, wood

MATERIALS

- Common cleaning sponges

- Markers
- Rulers
- Books or blocks

ACTIVITY

1. Take a plastic ruler and place it on two books which are set a few inches apart. Have the students observe what happens to the ruler as you push down on the center of the ruler. They will notice that the ruler moves at its ends and bends slightly. This illustrates how a beam reacts when it has a force applied to it. See Figure 1.
2. Recall with the students the terms compression and tension. Ask them which one applies to the ruler. Was the ruler experiencing compression or tension when you applied load to it?

   The answer is both. There is tension along the underside of the ruler and compression along the top.
3. Hand out a sponge and marker to each student.
4. Have the students draw a set of evenly spaced, vertical lines on one of the narrow sides of the sponge. See Figure 2.
5. Have the students hold the sponge along its short sides. Have them bend the sponge to create a humped shape. While bending the sponge, have the students observe what happens to the lines on the side. See Figure 3.
6. Again, review the terms compression and tension. Remind the students that compression shortens the distance from end to end and tension lengthens the distance from end to end.
7. Have the students identify the part of the sponge that is in tension and the part that is in compression.

   Like the ruler, the bottom is in tension while the top is in compression.
8. Next, have the students draw a horizontal line which is perpendicular to their vertical lines, and that is located at the mid-thickness of the sponge.
9. Have the students bend the beam a second time, again forming a hump.
10. At the level of the horizontal line, examine what happened to the distance between the vertical lines. Answer: there is no change in this distance as a result of bending the sponge.
11. What happened to the overall length of the horizontal line?

    Answer: nothing. The length of the line is not changed. The length of the horizontal line, and distance between the vertical lines, remain unchanged. This is because the beam is neither in compression nor *tension along this line. The horizontal line is called the neutral axis of the beam. The ruler also has a neutral axis, but its thickness is too small for the neutral axis to be observed.*

ACTIVITY #2

1. Have the students hold the sponge at one end and then push down on the other end with their fingers. The vertical and horizontal lines should be facing the students as before.
2. A beam supported at only one end is known as a cantilever beam. Cantilever beams are used to create balconies in buildings and other types of overhanging structures.
3. What happens to the vertical lines when the sponge is supported and loaded like a cantilever? Answer: the vertical lines spread apart along the top edge and become closer together along the bottom edge.
4. Have the students identify the beams used in the construction of their school building or other buildings which are familiar to them.

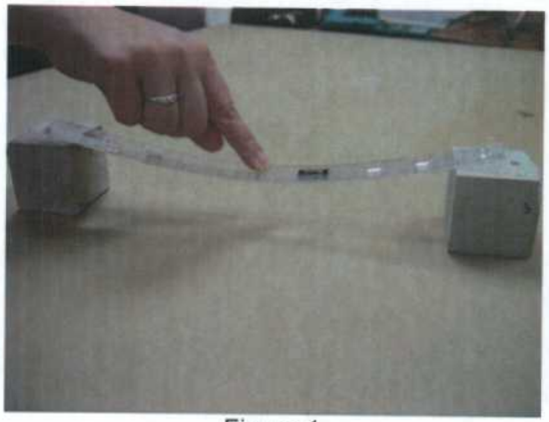


Figure 1

Figure 2

Figure 3

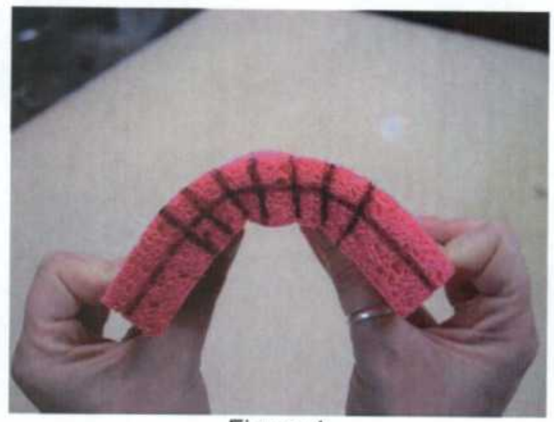


Figure 4

THE BRIDGES OF PAPER COUNTY

3-5 STRUCTURES **Lesson 3**

OVERVIEW

While we believe that no two snowflakes look alike, the same cannot be said for highway bridges. The materials used and the arrangement of the structural components are selected so as to produce a safe, economical, and functional means for traffic to cross over an obstacle. What is different about each bridge is generally not visible to the naked eye. The strength of the materials used and dimensions of the components are two examples of features which can not be seen, or readily differentiated, when compared with another structure. However, these are the features which make the structure strong, safe, economical, and functional.

If the properties of the materials used in a group of bridges are held constant, then the arrangement of the various components becomes the key factor in establishing the load carrying capacity (strength) of each bridge. In other words, the shape and position of the beams or truss elements will make one structure stronger than another. Thus, structural engineers work with shape and placement to find a configuration which will provide sufficient strength at a reasonable cost.

Note that the students are asked to complete a homework assignment prior to conducting this activity in the classroom.

OBJECTIVES

The students will be able to:

1. sketch different bridge configurations.
2. understand that shape and placement have an impact on the strength of a structure.
3. define and spell, as appropriate, the following vocabulary words
    - configuration, position, arrangement, placement, structure, component

MATERIALS

- Printer paper and notebook paper

- Paper clips
- Books or Blocks
- Pennies (100), metal washers, or small weights
- Scissors
- Camera

ACTIVITY

1. A few days before conducting this activity, give the students the following homework assignment. Have each student take notes on 2 to 4 different bridges that they saw while traveling around the city. Have them make a simple sketch of each bridge. Collect these sketches and group similar type bridge configurations together.
2. Hold up a piece of printer paper and ask the students to predict how many pennies the piece of paper will support if it is placed between to supports (books) like a bridge.
3. Have each student record their predication on a piece of notebook paper. Also, ask them to record, with words or a drawing, what will happen to the shape of the paper as pennies are placed on the top of the paper.
4. In a location where all the students can see, place two books, or blocks, about 8 inches apart on a table or desk. Place the paper flat across the books or blocks. See Figure 1.
5. Start placing pennies on the paper, having the students count the pennies as they are placed on the paper. Place the pennies at the mid-point of the bridge. Keep putting pennies on the paper until the "bridge" fails. See Figure 1.
6. Next, take the same piece of paper and fold it several times along its length so that the paper has an accordion style shape. See Figure 2. Place this new bridge on the book (block) supports. Again, have the students record their prediction of the number of pennies the bridge will support.
7. Place pennies in the "V's" of the paper, again starting in the middle. Have the students count the number of pennies added before the bridge fails.
8. Ask the students for their thoughts on why the second bridge was able to support so much more weight when both bridges were made from the same piece of paper.

   The shape and arrangement of the pieces of a bridge are selected so that they will support the most load. The best shape and arrangement of the pieces depends on the material used to build the bridge as well as the *distance between the supports. By folding the paper, the bridge became stiffer (less likely to bend) which in turn made it stronger (can support more load).*

9. Divide the class into small groups of a manageable size.
10. Give each group a piece of printer paper, paper clips, scissors, a ruler, pennies or other weight, and books or blocks.
11. Challenge the groups to design their own bridge out of a piece of printer paper so that it will hold as many pennies as possible. Note that the paper can be cut, folded or both and that paper clips can be used to construct the bridge.
12. Before pennies are added to the group bridges, take pictures of each for a future display.
13. Have each group record the number of pennies added before failure. Also, have the groups comment on what happened to the shape of the bridge as it was failing.

Figure 1

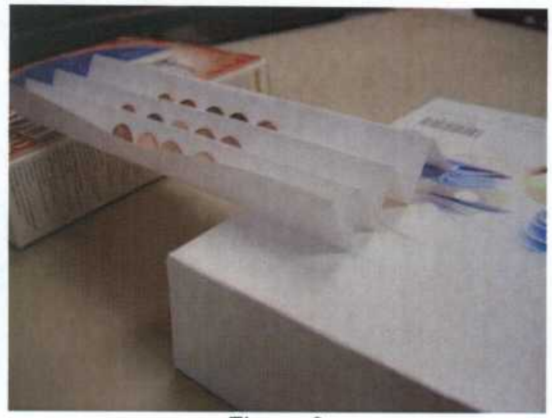


Figure 2

I'M STUCK AND CAN'T GET DOWN !!

6 - 8 STRUCTURES **Lesson 1**

OVERVIEW

For a structure to stand and carry the loads placed upon it, its various components must be adequately connected together. These connections are referred to as joints. If a joint fails, an entire structure can collapse. As a result, structural engineers spend as much time, if not more, validating the integrity of the joints as they do the main members of a structure.

Joints within a large-scale steel structure are typically bolted together. Those in a concrete structure are less noticeable as they are surrounded by concrete. In more modest structures such as homes, adhesives are often used when screws and nails are either difficult to use or they take away from the aesthetic quality of the structure.

If you ask a civil engineer to identify the most versatile of all joint or construction materials, they will most likely respond with "duct tape". Duct tape is strong when subjected to both compressive (compress) and tensile (pull apart) loads. It can adhere to nearly any surface, and can take on nearly any shape, as will be demonstrated by this lesson plan.

OBJECTIVES

The students will be able to:

1. duct tape a classmate to the wall, and have some fun while doing so
2. define the following vocabulary words
    - integrity, connections, compressive load, tensile load, joints, structural engineer

MATERIALS

- 50 feet of duct tape for each group
- A box, stack of books, or other "step" from 6 to 12 inches in height

ACTIVITY

This activity has a significant element of fun combined with an engineering concept.

1. Teams will consist of four members, one of which will be duct taped to a wall. The person to be taped to the wall will be weighed to the nearest pound on a standard bathroom type scale.
2. Each team will be provided at least 50 feet of duct tape.
3. The contest official (you) will give the teams the signal to begin the competition.
4. Two team members will be responsible for spotting a third member while they stand on a box approximately 6 to 12 inches off of the floor. The fourth team member will use the duct tape to tape their team member to the wall.
5. There are no restrictions on how the tape is used to secure the team member to the wall, other than both ends of a piece must be in contact with the wall. In other words. a piece can not go from the chest to the wall. Rather, it must go from the wall, across the chest, and on to the wall on the other side. See the cartoon below.

6. Each team will have five (5) minutes to secure one team member to the wall with the duct tape. On the signal from the contest official (you again), all teams must cease using the duct tape.
7. Again, on the signal from the contest official, elapsed time will be monitored.
8. Once any part of the duct taped member touches the floor, that person is considered to have fallen off the wall, and time will be stopped for that team.

9. The maximum time that a team member can be taped to the wall will be twenty (20) minutes. After twenty (20) minutes, any person still taped to the wall will be removed.

10. Each team must measure the total length of duct tape they used. Tape that gets tangled and discarded while trying to tape a team member to the wall must be included in the total length measurement. Thus, any length of tape removed from a roll must be accounted for.

11. The factors used to determine the winners of this competition will be the weight of the member taped to the wall, the length of duct taped used to secure them to the wall, and the time the team member was stuck to the wall. The following formula will be used to compute the score for each team.

12. Score = [weight (lb) x time (min)] / length of tape (ft)

13. The team with the highest final score wins the competition.

14. Should two or more teams have the same score (to 1 decimal place), the team with the heaviest person taped to the wall will be declared the winner. If the weights of the team members are within 5 pounds, then the team using the shortest length of tape will be the winners. If these lengths are within 1 foot, then competition will be declared a tie.

IS THAT CEMENT OR CONCRETE?

6 - 8 STRUCTURES **Lesson 2**

OVERVIEW

Structures are generally built from one or more of the following materials: concrete, steel, wood, or masonry block. Of these materials, concrete is the most widely used. In fact, there are places in the world that have no access to steel or wood and thus use only concrete or masonry block in construction. Note that masonry block is fabricated from the same materials used to produce concrete.

A basic concrete mixture consists of cement, water, rock, and sand. Cement is a gray powder that when combined with water will set and gain strength. Rock and sand are used as fillers. These materials add volume to the concrete mixture, with little additional cost. Concrete is a material that can resist high levels of compressive (squeeze) loads. However, it is much weaker when subject to tensile (pull apart) loads.

What makes concrete strong or weak? For the most part, it is the ratio of the weight of water to the weight of cement in the mixture. If a mixture contains 10 lbs of water and 20 lbs of cement, the water to cement (w/c) ratio is 0.50. When the w/c ratio is small, less than about 0.45, then the strength of the concrete will be relatively high. However, when the ratio is high, above 0.45, the strength will be relatively low. Another factor affecting strength is the age of the hardened mixture when its strength is measured. A concrete mixture will continue to gain strength for about 28 days after the concrete is produced. Concrete's strength is generally measured by applying an increasing compressive load until the test sample breaks.

OBJECTIVES

The students will be able to:

1. identify the ingredients of concrete
2. mix, cure, and then test small samples of concrete
3. define the relationship between the amount of water in concrete and its compressive strength

4. define the following vocabulary words.
   - fabricate, foundation, compressive load, tensile load, compressive strength, tensile strength, cement, concrete

MATERIALS

- Paper towel or toilet paper rolls
- Scissors
- Aluminum foil
- Mixing bowl and tablespoon
- 3 containers – one for water, one for sand, one for cement
- Water
- Sand (obtained from a home center)
- Cement (obtained from a home center)
- Rubber gloves
- Balance (scale)
- A workshop vice

ACTIVITY

Note that prolonged exposure of bare skin to cement paste can lead to a chemical burn due to the lime in the cement powder. Therefore, **it is imperative that students wear rubber gloves throughout this activity!**

1. Divide the class into small groups of a manageable size.
2. The toilet paper and paper towel tubes will serve as the molds for the concrete mixture. Cut any paper towel tube into half or thirds to create 2 or 3 molds respectively. Cover one end of these molds using the aluminum foil. Label each tube, or cylinder, by group name or number.
3. Using the balance (scale), have each group obtain 1 pound of sand, 2/3 pound of cement, and 1/3 pound of water (w/c = 0.50), each in its own container.
4. In a mixing bowl, add and mix the sand and cement together. After the sand and cement are thoroughly mixed begin to add water. Be sure to continue mixing all materials together as the water is added. With

continued mixing, the concrete should begin to take on a consistency similar to that of a cake batter.

Make sure that each student wears a pair of rubber gloves throughout the entire project.

5. Once all materials are well mixed, use a tablespoon to place the concrete mixture into a paper cylinder mold. Use the spoon to lightly compact the mixture in the mold. Continue to add concrete to the mold until it is full.
6. Remove any excess concrete from the open end of the cylinder mold by using the handle of the spoon in a sawing motion. Move the spoon handle back and forth to insure that the surface of the concrete is level with the top of the cylinder, as well as being fairly smooth.
7. **Be sure to clean all pans, spoons, etc. so that the concrete will not harden on the equipment.**
8. Place the filled molds in a location where they will not be disturbed. Allow the concrete molds to set and gain strength for seven (7) days.
9. Remove the paper tube molds from the hardened concrete. There is no need to save these molds; so they can be torn off the concrete.
10. Determining the magnitude of compressive load that a concrete cylinder can withstand requires the use of large and expensive equipment. In lieu of this type of testing equipment, a vice typical of that found in a wood or mechanics shop will be used. Further, turns on the vice handle will be counted rather than force being monitored.
11. Place a concrete cylinder horizontally into the vice. The ends of the cylinder should be positioned against the jaws of the vice. Close the vice just until the cylinder can not be removed from the vice by hand.
12. Begin to compress the cylinder mold by turning the handle on the vice. Count the number of whole, half, or quarter turns of the handle. Continue to turn the handle until the concrete cylinder begins to show distinct evidence of cracking and splitting.
13. Record the final number of turns of the handle. Rather than relating a load to a w/c ratio, turns of the vice handle can be related to the w/c.
14. Repeat the compressive test on all concrete cylinders.
15. For comparative purposes, consider the following optional procedures.
    a) Have groups use different w/c ratios for their mixtures. Keep the cement and sand contents constant and just add more, or less, water to the mix. Compare the turns on the vice to the w/c ratio.
    b) Use the same mixture for all groups but test the cylinders at different ages, such as 7, 10, 14, 21 or 28 days after the molds are cast. Compare the turns on the vice to the age of the cylinder.

c) Use the mixture described in the activity above. Remove the paper molds from the cylinders the day after the cylinders are cast. Place half of the cylinders in a tube of warm water and the rest on a shelf in the classroom. Compare the turns on the vice to the storage environment for the cylinders.

HOW DENSE CAN YOU BE?

6 - 8 STRUCTURES **Lesson 3**

OVERVIEW

When a civil engineer designs a structure it is necessary to anticipate all of the forces that might someday act upon the structure. Forces to be considered are people, equipment, furniture, wind, snow, earthquakes, and rain. Another key force is the weight of the structure itself. Just like the human skeleton, a structure must be able to support its own weight, often referred to as self-weight.

A structure's self-weight is a function of the dimensions of each component (in^3, ft^3, etc.), as well as the weight of the construction material (lb/ft^3, lb/in^3, etc.). By multiplying the volume of a component (beam, column, floor, roof) by the weight of the material. the result will be the total self-weight of that component. In order to make this calculation, it is necessary to know the weight, also referred to as unit weight or density, of the construction material. Unit weight, or density, represents the weight of a unit volume (1 in^3 or 1 ft^3) of material.

OBJECTIVES

The students will be able to:

1. explain the concepts of density and self-weight
2. compute densities and self-weights for various materials
3. define the following vocabulary words
   - dimensions, calculation, unit weight

MATERIALS

- A scale (balance)
- Graduated cylinder if irregular shaped samples of material are used
- Pieces of material of various size and type
- Calculator
- Chart paper

- Markers
- Ruler, preferably one with 0.1 inch increments
- Balance (scale) for measuring small weights (0.1 g scale preferred, 1g scale acceptable, 10g scale will not be acceptable). See Figure 1 for an image of a scale.

ACTIVITY

There are two approaches that can be taken with this lesson plan. One option is to determine the density of various types of materials. These densities can be compared to known, widely accepted, values. Another option is to use known values for density and measured dimensions to compute the weight of a piece of material. This computed weight can then be compared with a measured weight.

OPTION 1

1. Place a sample of material on the scale and record its weight to the nearest 0.1 or 1.0 gram, depending on the resolution of the scale. Note that there are 454 grams in 1 pound.
2. Measure the dimensions of the piece of material in inches. Make these measurements to the nearest 0.1 or 1/16 of an inch, depending on the scale on the ruler.
3. Compute the volume of the material in a manner appropriate for its shape. As an alternative, and for samples of material of irregular shape, place the material in a graduated cylinder partially filled with water. The difference between the original water level and level after the sample as been submerged represents the volume of the sample in cubic centimeters.
4. Divide the weight (lb) of the sample by its computed, or measured, volume (in^3) to determine the density, or unit weight, (lb/in^3). Record the computed values on the chart paper.
5. Table 1 provides a list of generally accepted values for the density of materials. Compare the computed values found by the students with the values found in Table 1. Discuss any difference between computed and tabulated values.

OPTION 2

1. Take a sample of material and determine its dimensions per Step 2 or 3 from above.

2. Select the appropriate density value from Table 1.
3. Compute the weight of the sample of material by multiplying the volume by the density. Record this value on the chart paper.
4. Place the sample of material on the scale to measure its weight. Record this value on the chart paper.
5. Compare the computed weight with that recorded from the scale. Discuss any differences between the two values.

Figure 1

Figure 2

Table 1

Material	Density
Concrete	145 lb/ft^3
Steel	490 lb/ft^3
Soil	100 lb/ft^3
Rocks	100 lb/ft^3
Timber	Various

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

HOME

GEOTECHNICAL
engineering

K to 2nd Grade

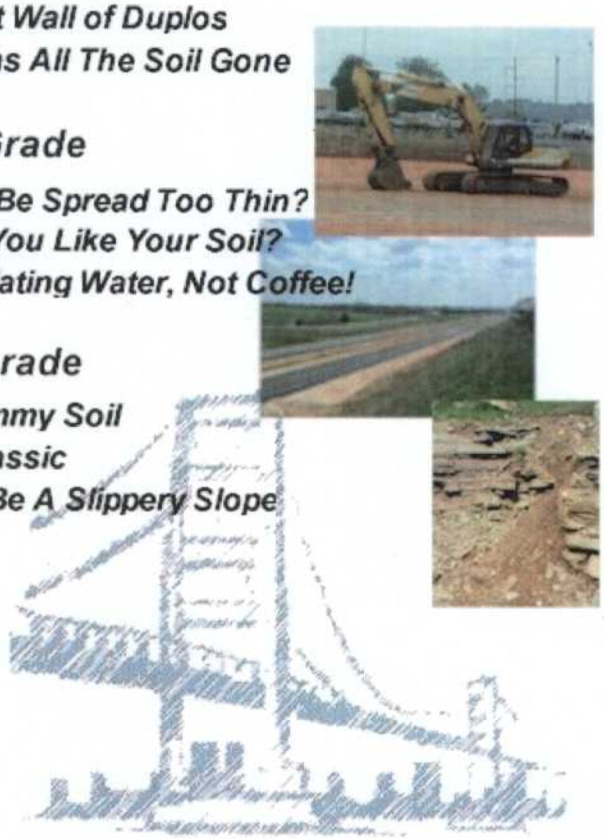
- Foundations: More Than A Cosmetic
- The Great Wall of Duplos
- Where Has All The Soil Gone

3rd to 5th Grade

- Can You Be Spread Too Thin?
- How Do You Like Your Soil?
- Its Percolating Water, Not Coffee!

6th to 8th Grade

- That Crummy Soil
- Soil, A Classic
- Soil Can Be A Slippery Slope



Civil Engineering - A Bridge to the Future

FOUNDATIONS: MORE THAN A COSMETIC

K-2 GEOTECHNICAL **Lesson 1**

OVERVIEW

There is a popular saying that only two things are guaranteed in life: death and taxes. Make that three things: death, taxes, and all forces must eventually be resisted by the ground. While the last item might be long-winded, it is still a fact. The earth's surface supports all structures, vehicles, people, equipment, toys, and so on. However, each point on the earth's surface is NOT created equal in terms of its ability to resist the applied forces. Thus, when a structure is to be built, it is important that the properties of the soil in the area be known. These properties are then used to design an adequately sized foundation. Once built, the foundation should not move. Thus, both initial and long-term properties of the soil are important pieces of information.

OBJECTIVES

The students will be able to:

1. list various materials which might be used in building foundations for structures and roadbeds.
2. discuss the importance of having a strong, stable, foundation.
3. define and spell, as appropriate, the following vocabulary words.
   - foundation, roadbed, build, strong, stable, soil, sand

MATERIALS

- Books about building roads
  - Building the New Road – by Justine Korman-Fontes and Steven James Petruccio (Illustrator)
  - Road Builders – by B. G. Hennessy and Simms Taback (Illustrator)
- Pictures of foundations, roadbeds, and the machinery that helps build these structures from the image file on the CD
- Chart paper
- Markers

- Soil (not potting soil) and sand
- Some form of a block, the material the block is made from is not important, as long as it is strong enough to be pushed on.
- 2 baking pans (for example, 9" x 9" or 9" round)

ACTIVITY

1. Explain the concept of a foundation to the students, as well as the importance of having a strong and stable foundation.

   A foundation is a type of structure which supports a building, bridge, dam, roadway, or other structure. The foundation helps to spread the weight of a building, etc across the earth. Foundations need to be strong and stable so that the building, etc does not move while in use.

2. Ask the students to describe what happens when they walk on sand or on muddy ground.

   The important point here is that the sand/soil will subside and thus your foot sinks into the sand/soil.

3. Discuss why this "sinking" does not occur when you walk on solid, dry ground.

   The important point here is that the material does not compress, thus your foot does not sink.

4. Work with the students to create a list of the types of materials, other than sand or soil, which might make a good foundation for a building or roadway. Allow them to be creative with their suggestions. Thus, some suggestions may not be practical, but that is ok. Use the chart paper and markers to record this list.
5. Explain that all structures, buildings, bridges, roadways, etc, are supported by the ground. Also note that the ground consists of both soft and hard materials. Therefore, there are locations where sinking could occur and other locations where sinking would be less likely to occur.
6. Heavy things sink in soft ground, such as sand or mud. Illustrate this by pushing the block into a pan filled with sand. See Figure 1. Then push this same block into a pan filled with damp soil. See Figure 2.
7. Have the students describe what happened in each case. Some questions to prompt student responses might include, a) Did the block sink or not?, b) If the block sank into the "soil" did it sink a lot or a little? c) Does the block appear to be stable as it rests in the pan?

8. Read one of the suggested books about roadways and foundations to the class. Select, and discuss, a few of the important points from the book. Add, as appropriate, to the list mentioned in Item 4 above.

ADDITIONAL ACTIVITY

1. Identify one or more of the materials on the list from Items 4 and 8 above. Place a sample of this material in a pan and push a block into the material. Discuss how this material behaved compared with the sand and soil.

Figure 1

Figure 2

THE GREAT WALL OF DUPLOS®

K-2 GEOTECHNICAL Lesson 2

OVERVIEW

There is a popular saying that only two things are guaranteed in life: death and taxes. Make that three things: death, taxes, and all forces must eventually be resisted by the ground. While the last item might be long-winded, it is still a fact. The earth's surface supports all structures, vehicles, people, equipment, toys, and so on. However, each point on the earth's surface is NOT created equal in terms of its ability to resist the applied forces. Thus, when a structure is to be built, it is important that the properties of the soil in the area be known. These properties are then used to design an adequately sized foundation. Once built, the foundation should not move. Thus, both initial and long-term properties of the soil are important pieces of information.

OBJECTIVES

The students will be able to:

1. discuss the importance of having a strong, stable, foundation.
2. work as a member of a team.
3. identify the benefits and deficiencies of different foundation materials such as stone, sand, and soil.
4. define and spell, as appropriate, the following vocabulary words.
    - foundation, roadbed, build, strong, stable, soil, sand

MATERIALS

- 2 pans (for example, 9' x 9" or 9" round) per group
- Sand, Soil (not potting soil), stones, Play-Doh®
- Duplos®, Lego's ® or equivalent
- Chart Paper
- Markers
- Notebook paper

ACTIVITY

1. Divide the class into small groups of a manageable size.
2. Explain the concept of a foundation to the students, as well as the importance of having a strong and stable foundation.

   A foundation is a type of structure which supports a building, bridge, dam, roadway, or other structure. The foundation helps to spread the weight of a building, etc across the earth. Foundations need to be strong and stable so that the building, etc does not move while in use.

3. Have the groups predict which foundation material: sand, soil, stones, or Play-Doh®, will be the best to build a structure on. Record the group predictions on the chart paper.
4. Using the Duplos®, or equivalent, have each group build a "wall" about 6 inches long and about 4 inches high. See Figure 1 or 2. Have the groups follow your lead in building their wall.
5. Have each group put about 1 to 2 inches of soil into one pan and the same amount of sand into the other. Instruct the groups to spread the soil and sand evenly across the bottom of the pans. See Figures 1 and 2.
6. Have the groups place their wall in the pan with the soil and then push down to mimic the weight of a structure. Each group will then record their findings on the notebook paper provided.

   Findings might include whether the wall sank into the material or not, if it did sink was it a lot or a little, after letting go of the wall did it tip over or not, etc.

7. After the groups have completed the above task, have them repeat the test with the pan filled with sand.
8. Repeat steps 4 through 7 using the stone and Play-Doh®.
9. Bring the class back together and discuss the findings of each group for each material. Record these findings on a piece of chart paper. Have the class decide which material would be best for building a structure or roadway upon.


Figure 1

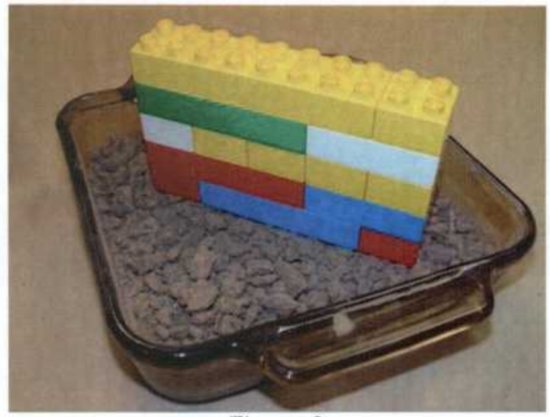


Figure 2

WHERE HAS ALL THE SOIL GONE

K-2 GEOTECHNICAL Lesson 3

OVERVIEW

One of the most recognizable lighthouses in this country is the Cape Hatteras lighthouse on the coast of North Carolina. In 1999, this structure had to be moved nearly 3000 feet inland as the surrounding coastline was eroding at a relatively fast rate. This beach erosion was placing the lighthouse in danger of collapse as the support for the foundation was being lost. Another very recognizable example of erosion is the Grand Canyon. This canyon was craved out of the earth over hundred's of years by the action of the Colorado River. Any structure which might have been built across this river would have been lost as the canyon widened with time. Closer to home (literally), one can see the effects of erosion by observing the action that rain water coming off the roof has on the soil surrounding the house, or at the base of a downspout. Big or small, national or local, water (and wind) can have a significant impact on the movement of soil (and sand) which in turn can have a significant impact on how well a structure's foundation is support by the ground.

OBJECTIVES

The students will be able to:

1. identify different types of erosion.
2. identify the effects of wind and water on landforms.
3. define and spell, as appropriate, the following vocabulary words.
    - erosion, sand, dunes, wind, water

MATERIALS

- Sand
- 9x9 cake pan
- Measuring cup
- Spoon
- Several drinking straws

- Several small bottles of water
- Paper
- Pencil

ACTIVITY

1. Explain the concept of erosion to the students.

   Erosion is the movement of material, such as soil and sand, through the action of wind, water, or both on that material.

2. Chose either or both of the following experiments for the students to perform.

Wind Erosion

1. Discuss with the students what a sand dune looks like. Quiz the students to determine if they understand how a sand dune is formed. If they are unsure, don't give away the answer just yet.
2. Have the students form small groups.
3. Give each group a cake pan, some sand, a measuring cup, and enough drinking straws for each student to have one.
4. Have the students measure ¼ cup of sand and then place it in the pan.
5. Tip the pan so all of the sand will move to one side. See Figure 1.
6. Using the straw, and a deep breath, have the students slowly blow through the straw to see how much sand they are able to move from one side of the pan to the other. See Figure 2.
7. Now, revisit the question of how a sand dune is formed. Ask the class if they can think of another "material" that is moved by the wind similar to sand.

   One example is snow and snow drifts.

Water Erosion

1. Have the students form small groups.
2. Give each group a cake pan, some sand, a measuring cup, and a bottle of water.
3. Have the students measure ¼ cup of sand and then place it in the pan.

4. Tip the pan so all of the sand will move to one side. See Figure 1.
5. Slowly pour water on to the sand, keeping the bottle in one location. See Figure 2.
6. Have the students make note of how quickly the sand moves, in what direction it moves, how much effort it took to move the sand compared to blowing through the straw (assuming the wind erosion experiment was conducted). See Figure 3.
7. Bring the small groups back together. Discuss examples of water eroding sand and soil. Some examples include sand on ocean beaches, the Grand Canyon, and flooding.

Figure 1

Figure 2

Figure 3

Figure 4

CAN YOU BE SPREAD TOO THIN?

3-5 Geotechnical Lesson 1

OVERVIEW

Buildings, bridges, and other structures will have their supporting elements, like a pier for a bridge, placed on a footing which in turn is placed on the earth. See Figure 1. The purpose of the footing is to spread out the weight of the structure rather than have it concentrated in a smaller area, like at the columns in a bridge pier.

Another form of "footing" is the landing gear on a plane. Larger planes will have many more tires on their landing gear when compared with smaller, lighter, planes. If you divide the weight of an airplane by the total number of tires on the landing gear you will find the portion of the total weight resisted by each tire. To keep the weight per tire low, it is necessary to add tires to the landing gear as the weight of the aircraft increases. If the weight on a tire is too great it will fail when the pilot attempts to land the plane. If the weight on the soil from a structure is too great, the structure will sink into the soil and be damaged. Neither of these scenarios is acceptable when considering the safety of the general public.

If money was no object, we would build very large foundations so that the force on the soil would be very small. However, we are concerned about the cost of construction. Thus, it is necessary to balance the cost of a foundation with the magnitude of force being transferred to the soil.

OBJECTIVES

The students will be able to:

1. The students will be able to observe the effects of surface area and how it affects the performance of a foundation.
2. define and spell, as appropriate, the following vocabulary words.
   - foundation, structure, support, spread, column

MATERIALS

- Small cake pan (9in x 9in, or 9in round pan)

- Soil (not potting soil)
- Spoon
- Pencil
- Dime
- Quarter
- Jar lid (2" – 3" in diameter)
- Notebook paper

ACTIVITY

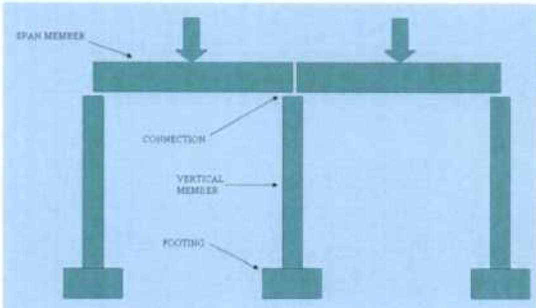
1. Divide the students into groups of a manageable size.
2. Give each group a small cake pan, a supply of soil, a spoon, pencil, dime, quarter, and a lid from a jar.
3. Using the spoon, fill the pan about one-half full with soil. Do not compact the soil. Use the spoon to level out the soil in the pan.
4. Have the students take a pencil and, with the eraser end, press it into the soil. Observe and record the results. See Figure 2.
5. Next, place the dime on the surface of the soil. Make sure that the dime is positioned in a new location. Place the eraser end of the pencil on the dime. Press the pencil onto the dime so that the dime is pressed into the soil. Observe and record the results. Make a relative comparison with the results from using the pencil alone. See Figures 3 and 4.
6. Repeat Step 5 using the quarter. See Figures 5 and 6
7. Repeat Step 5 using the jar lid. See Figure 7.
8. After the students have completed the above task bring the class back together to discuss the findings of each group.

   Note that larger surface areas sink less into the soil. Thus, the size of a foundation is an important factor in how well a structure is supported by soil.

ALTERNATE ACTIVITY

Repeat the exercise described above but with the following modifications

1. Use sand, small pebbles, or other material in lieu of the soil.
2. Use a plastic cup to compact the soil in the pan prior to continuing with the experiment.



Thanks Dr. Max Porter at Iowa State University.

Figure 1

Figure 1

Figure 3

Figure 4

Figure 5

Figure 6

Figure 7

HOW DO YOU LIKE YOUR SOIL?

3-5 Geotechnical **Lesson 2**

OVERVIEW

Why are people fascinated by the Leaning Tower of Pisa? It's because the tower is leaning! Would we really care that much about this tower if it wasn't leaning? Well then, why does the tower lean? The tower leans because of the poor condition of the foundation that the tower is built upon. Today's restoration efforts are directed at stabilizing the foundation beneath the tower so that it will cease to tip, and possibly be righted to a certain degree.

All structures, buildings, bridges, roadways, etc are ultimately supported by the earth's soil. When the condition of the soil is inadequate to support a structure, measures can be taken to improve the properties of the soil. One example is to compact the soil. By compacting the soil you increase its density, strength, and stability, all features we prefer in a foundation soil. The degree of compaction will determine the extent of any improvement in the soils ability to adequately support a structure.

OBJECTIVES

The students will be able to:

1. understand that a foundation is as much of a structure as the road, building, or home that is built upon it
2. observe how the properties of soil can change when it is compacted
3. define and spell, as appropriate, the following vocabulary words.
   - foundation, compaction, structure

MATERIALS

- ¼ Sheet cake pan
- Soil (not potting soil)
- Toy car
- Large spoon
- Plastic cup

- Several sheets of craft paper

ACTIVITY

1. Divide the students into groups of a manageable size.
2. Give each group a cake pan, supply of soil, one large spoon, three pieces of paper, a toy car, and a plastic cup to compact the soil.
3. Have the students use the spoon to place the soil in the pan until it is about one-half full. The soil represents the foundation on which a pavement is to be built. Roughly level the soil in the pan with the spoon. See Figure 1. Make no effort to compact the soil, rather it should be loosely placed in the pan.
4. Place a sheet of craft paper on top of the soil. Have one student in each group "drive" their car across the paper. While the car is being "driven" across the paper, have the group observe what happens to the paper. See Figure 2. After "driving" the car across the paper, set the paper aside for future use.

   The craft paper should crinkle noticeably as the car is driven across it.
5. Using the plastic cup, <u>gently</u> compact all the soil in the pan. If the soil compacts easily, it may be necessary to add more soil to the pan. <u>Gently</u> compact any additional soil. After all the compaction is complete, the soil should be relatively level.
6. Place the second sheet of craft paper on top of the partially compacted soil. Again, have one student in each group "drive" their car across the paper. After "driving" the car across the paper, set the paper aside for future use.

   The craft paper should again crinkle, but not as much as before.
7. Using the plastic cup, <u>firmly</u> compact all the soil in the pan. See Figure 3. If the soil compacts easily, it may be necessary to add more soil to the pan. <u>Firmly</u> compact any additional soil. After all the compaction is complete, the soil should be relatively level. Also, it should be very difficult to make an impression in the soil with your finger or thumb.
8. Place the third sheet of craft paper on top of the fully compacted soil. Again, have one student in each group "drive" their car across the paper. After "driving" the car across the paper, set the paper aside for future use.

   The craft paper should crinkle very little, if at all.
9. Set the three sheets of craft paper side-by-side so that the members of each group can clearly see the amount of crinkling that occurred with each sheet. See Figure 4.

10. Bring the groups back together. Have them consider a scenario where a building is to be constructed on a soil foundation. Ask for their thoughts on what might happen over time to a building located on the loose, partially compacted, and fully compacted soil.

Figure 1

Figure 2

Figure 3

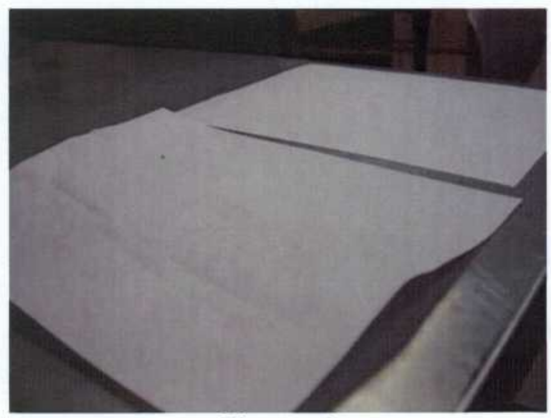


Figure 4

IT'S PERCOLATING WATER, NOT COFFEE!

Geotechnical 3-5 **Lesson 3**

OVERVIEW

In most, but not all, circumstances a structure is built on compacted soil. If the degree of compaction is insufficient, then columns of concrete or steel are driven into the earth until they reach a strong solid layer of material. These columns are referred to as piles and they are pounded into the earth with a pile driver. Whether piles are needed or not is determined by measuring the compaction of the soil. One method of checking compaction is by a percolation test. This test is generally performed when installing a septic system, or whenever it is necessary to have a good flow of water through the soil. Nevertheless, it is an indicator of soil compaction as water will move quickly through loose soil and slowly through compacted soil.

This lesson was inspired by information found at the Underground Network web site, http://www.fmnh.org/ua/netsoil.htm.

OBJECTIVES

The students will be able to:

1. perform a test on soil to establish a relative measure of compaction
2. explain why water passes through a non-compacted soil more quickly than for a compacted sample
3. define and spell, as appropriate, the following vocabulary words
    - percolate, compaction, columns

MATERIALS

- An empty, and clean, soup, fruit, or vegetable can.
- A can opener
- A marker
- Ruler
- A pan or bowl, having a flat bottom, and a size about twice the diameter of the can to be used.

- Soil (not potting soil)
- Tamping tool
- A cup, or other container, to hold water
- Stop watch, or watch with a second hand

ACTIVITY

1. For this project, the students can work in small groups or individually.
2. Have the students remove the labels from their cans. With the can opener, remove the closed end of the can.
3. Using the marker, place two marks on the inside of the can. One mark should be about 1 inch from the end of the can while the other is about 2 inches from the same end.
4. Place the can, with the marked end down, into the pan. Fill the can with soil up to the 2 inch mark.
5. Fill the remainder of the can with water.
6. Using the watch, measure the amount of time required for the water to soak through the soil into the pan.
7. Clean the pan and can.
8. Next, fill the can with soil up to the 2 inch mark. Use the tamping tool to compact the soil to the 1 inch mark.
9. Fill the remainder of the can with water. Again, measure the amount of time it takes for the water to soak through the soil.

   Note that it should take longer for the water to soak through when compared with the non-compacted soil.
10. Repeat steps 7, 8, and 9, but this time compact the soil as much as possible.
11. Collect the data recorded by each student, or group. Determine a class average time for each soil condition (loose, partially compacted, fully compacted) tested.

THAT CRUMMY SOIL

6 - 8 GEOTECHNICAL Lesson 1

OVERVIEW

Do you ever wonder where soil comes from? Soil is, in part, small particles of rock; particles that are even smaller than sand in many cases. How does rock become soil? Over time, larger rocks are broken down into small particles by both chemical and physical mechanisms. In almost all cases, water is a component in the decomposition of rock.

Water moving around a rock on a river bed will cause pieces of the rock to be removed, eroded, from the rock surface and deposited elsewhere. This physical action is verified by the fact that a jagged edged rock left in flowing water for several years will become a smooth rounded piece of gravel. In cold environments, water that permeates a rock will freeze. When water freezes it expands which causes the rock to break apart. As this action continues, again over many many years, the larger piece of material will be reduced in size. This physical mechanism is referred to as freeze-thaw action. Chemical decomposition occurs when water permeates the rock initiating an internal chemical reaction. As with freeze-thaw action, the chemical reaction causes an internal expansion, which in turn causes the rock to crack and break apart.

These small particles of rock, or soil, become enriched by the decomposition of plant material and by the fertilization of animal waste. After thousands of years, what was once a large rock is now part of a rich black soil suitable for planting crops or upon which structures are built.

OBJECTIVES

The students will be able to:

1. demonstrate how large rocks can decompose into small particles of soil
2. define the following vocabulary words.
   - decomposition, permeate, fertilization, environment, mechanism, erosion

MATERIALS

- Several cubes of sugar

- Several zip-style snack or sandwich bags
- Water
- A 1/3 cup measuring cup
- Pebbles
- A freezer

ACTIVITY

1. Place one sugar cube into a zip-locking plastic bag and add about 1/3 cup of water. Zip the bag closed.
2. Confident that the bag is properly closed, shake the bag so that the water moves rapidly across the surface of the sugar cube. After several minutes of shaking, stop to examine the sugar cube. There should be evidence on the surface that the water removed, and/or dissolved portions of the sugar cube.
3. Shake the bag a second time, again stopping to observe any additional erosion that may have taken place. You can create a table for the number of times the bag was shaken vs. a verbal description of the extent of any erosion.
4. Place the bags in the sun, opening them slighty, and allow the water inside to evaporate. Once all the water in the bag has evaporated, you should be left with the particles of eroded sugar, which represent particles of soil.
5. Place one sugar cube into a zip locking plastic bag and add a few pebbles. Zip the bag closed.
6. Confident that the bag is properly closed, shake the bag so that the pebbles hit the sugar cube. After several minutes of shaking, stop to examine the sugar cube. There should be evidence that the pebbles removed portions of the sugar cube.
7. Shake the bag a second time, again stopping to observe any additional losses that may have taken place. Create a second table comparing the number of times the bag was shaken vs. a verbal description of the extent the sugar cubes were damaged.
8. The instructor is invited to try other types of "water" or other "hammers" than the ones suggested in this lesson. Regardless of the type of liquid or pebble used, record the number and duration of the shaking process so that any chart of the outcome can have an apples-to-apples relationship.

SOIL, A CLASSIC

6 - 8 GEOTECHNICAL **Lesson 2**

OVERVIEW

Soil, like a finger print, is unique. No two samples of soil, even from the same piece of earth, are exactly alike. This creates a problem of design for civil engineers as every structure, building, bridge, dam, and highway, is ultimately supported by soil. Therefore, if the soil characteristics vary at a construction site then the design of the foundation for the structure will also vary.

When accounting for the variability in soil properties at a construction site, it is necessary to take a practical, cost effective, approach. It is not feasible to sample, evaluate, and quantify the soil everywhere on the job site. Rather, a small sampling of soil from the site is collected, analyzed, and categorized with other like soils. A soil classification system allows the engineer to predict the strength properties and behavior of a soil based on the results of a few field or laboratory tests. Given the field and laboratory test results, the engineer attempts to categorize the soil sample into a group that has similar strength and behavioral attributes.

In addition to their strength properties, soils are classified based on visual observation and simple physical characteristics. Visual observation provides information on colors, particle sizes, evidence of layering, thickness of layers, and the presence of "foreign" particles. Physical characteristics include texture, density, and smell. While soil classification systems aide engineers in completing their work, such systems should not be regarded as the final answer in describing the properties and behavior of soil. Rather, classification systems represent another tool used by engineers in determining the load-carrying capabilities of a soil.

OBJECTIVES

The students will be able to:

1. collect data on a soil sample
2. use the data collected to establish a class of soil
3. use a classification system to identify an unknown sample of soil

4. define the following vocabulary words
   - classification, mechanical, observation, characteristics, attribute, foundation, civil engineering, variability

MATERIALS

- Garden scoop
- Zip-locking style plastic bag
- Magnifying glass
- Craft, packing, or other suitable paper for use as a work surface
- Paper and pencil for making notes
- Flip chart and markers

ACTIVITY

Depending on your location, this activity may best be conducted in the early fall or late spring when the ground is still fairly soft. This permits ease of sampling. Consider the state of the local soil conditions before proceeding with this activity. The soil should not be soggy.

Consider inviting a county extension agent to speak to the class regarding soil properties common to the particular area of the country. Perhaps the agent can perform a soil test from a soil sample taken from the school grounds. Compare these results and properties with the students' data.

1. Have each student in the class obtain about a 1 cup sample of soil from their yard at home, from the school grounds, from a near by park, or other suitable location. Stress that the samples should be taken with care. You want the sample to be as un-disturbed as possible.
2. For each student, lay out a piece of craft paper at their desk and provide them with a magnifying glass. Make sure that they also have a pencil and paper for making notes as they examine their soil samples.
3. Have the students record data from a visual observation and physical examination of the soil sample. They should comment on color, changes in color with depth, evidence of layering, particle size, the presence of foreign objects, smell, etc.
4. Once all the students have completed their examination, have them summarize their findings on a piece of chart paper. Have them use large

print so that the chart paper can be posted on a wall and seen by everyone in the class.

5. With all the student summaries on chart paper, which are posted for all to see, work with the students to find similarities in their descriptions of the soil samples. This work may produce 1, 2, 3, or more groups where the soils have similar attributes. Essentially, you are establishing your own local soil classification system. Give each common soil description a unique title.
6. As a homework assignment, have the students obtain another soil sample, as in Step 1 above, but from an entirely different location. Have them analyze their sample to determine which of the classifications the students identified earlier best describes their new soil sample.
7. Have the students make a table with three columns. Column 1 lists the attributes addressed by your local soil classification system. Column 2 lists the value for each attribute associated with the class of soil they believe their new sample most closely resembles. The third column lists the data they collected from their analysis of the new sample of soil.
8. Also, have the student write a brief paragraph as to why they selected the classification they did for their new soil sample.

SOIL CAN BE A SLIPPERY SLOPE

6 - 8 GEOTECHNICAL Lesson 3

OVERVIEW

The belief that soil can contribute to a dangerous circumstance is not widely held by the general public. This is a surprise when "back on solid ground" is a very common saying. However, there are many circumstances where soil itself, or actions induced by soil, can lead to a serious injury or worse. Examples include mud slides, sink holes, and slope failures.

When a new highway is being constructed through rolling terrain, earth may have to be removed from a hill so that the slope of the final highway is not too steep for tractor trailers, and other large and heavy vehicles. Earth, or soil, must also be removed and contoured to either side of the highway so that it does not fall onto the highway. The slope at which this soil is contoured affects its ability to stay in place and not slide on to the highway. The issue of an inclined soil face is referred to as slope stability.

It would seem obvious that a very shallow slope would be preferred as there would be little chance of the soil slope becoming unstable and sliding onto the highway. However, as the soil slope becomes shallower, the distance out on either side of the highway will increase. This means that a highway department must purchase more land to accommodate the slope, thereby increasing the overall cost of the construction project. Thus, it is necessary to balance the lower cost of a high angle of slope with the safety of a low angle.

OBJECTIVES

The students will be able to:

1. measure the inclination of a soil sample before it becomes unstable
2. compare angles of inclination for various types of soil
3. define the following vocabulary words
    - slope stability, angle of inclination, terrain, sink hole

MATERIALS

- Single use rectangular aluminum pans
- Protractor
- 3 to 5 cup volume of various soil samples, i.e. sand, clay, soil common to the local area, etc.
- Flip chart and markers

ACTIVITY

1. Divide the students into groups of a manageable size.
2. Have the students place about 3 to 5 cups of a soil/sand sample into the aluminum pan.
3. Move the soil to one end of the pan making sure that the top surface is level and that the thickness of material is uniform throughout. DO NOT compact the soil.
4. Have one student slowly raise the end of the pan were the soil is located. The student should continue to raise the end of the pan until a sizable portion of the soil/sand slides down the incline.
5. While one student holds the pan at the angle which causes the soil/sand to begin to slide, a second student uses the protractor to measure the inclination of the bottom of the pan. See Figure 1.
6. A third student can act as the data recorder for the group.
7. Steps 2 through 6 should be repeated two more times so that an average angle of inclination can be determined.
8. Repeat Steps 2 through 7 using different soil/sand samples, wet and dry samples, compacted and loose samples. Repeat the test three times for each sample of soil/sand considered.
9. The amount of water added to a sample to make it wet and the degree of compaction of a sample can be defined by the instructor. Further, wetness and degree of compaction could also become variables if desired.
10. Record the average values for each group on the flip chart. Have the students work together to identify the soil, and soil condition, which allowed for the largest angle of inclination. Do the same for the smallest angle.

Figure 1

TRANSPORTATION
engineering

HOME

K to 2nd Grade

- How To Get From Here To There
- Signs, Signs, Everywhere A Sign
- Through Thick And Thin

3rd to 5th Grade

- Which Way Do I Go?
- Vital Signs
- I Think I Can, ... I Know I Can

6th to 8th Grade

- You Can't Get There From Here
- I Can See Clearly Now
- Its Time To Check Your Speed

Civil Engineering - A Bridge to the Future

HOW TO GET FROM HERE TO THERE

K-2 TRANSPORTATION **Lesson 1**

OVERVIEW

Where once you could travel only by foot, today there are many forms of travel and several versions associated with each means of transportation. For example, today we have cars, trucks, SUV's, motorcycles, buses, RV's and more for travel on land. Each form of travel has its own particular design needs from the perspective of the engineer. The future is likely to bring more changes and new forms of transportation for the engineer to address.

OBJECTIVES

The students will be able to:

1. identify the basic types of transportation.
2. match pictures of transportation with the proper vocabulary word.
3. work in groups and design their own form of transportation.
4. define and spell, as appropriate, the following vocabulary words.
   - transportation, vehicle, automobile, car, traffic, travel, bus, airplane, train, boat, land, water, air

MATERIALS

- Images of different forms of transportation from the image file on the CD or other sources.
- Chart paper
- Notebook paper
- Pencils, pens, crayons, etc.

ACTIVITY

1. Show the class several pictures of different forms of transportation. With each picture, ask the students to name the form of transportation.

General categories for transportation include vehicle (land), boat (water), plane (air), and train (land).

2. As you show the class more pictures of transportation explain that there are several types of "vehicles" associated with each form of transportation. For example, vehicles can include cars, trucks, buses, motorcycles, etc.
3. Present appropriate vocabulary words from the list above. Help the students to read and understand these words.
4. Divide the students into small groups of a manageable size.
5. Give each group of students a few of the pictures of transportation you presented earlier. You can also add pictures from other sources if desired.
6. Have the students work together to group their pictures according to the forms of transportation identified earlier. Have one student from each group tell the class about one of the pictures from their group.
7. Using the chart paper, make a list of the examples presented by the students. These examples can provide the vocabulary words for the week.
8. Now, give each student a piece of notebook paper. Have the students design and color their own "vehicle". The students can then label their picture with the form of transportation it represents. Display these pictures in the classroom.

SIGNS, SIGNS, EVERYWHERE A SIGN

K-2 TRANSPORTATION **Lesson 2**

OVERVIEW

When automobiles were first invented there were no such things as road signs. Those who had cars would follow paths created by horse drawn carriages and would rely on common courtesy to avoid accidents. As the number of vehicles in use grew, common courtesy was no longer a viable means of traffic control. Today we have an extensive traffic control system of signs, lights, and laws. As we know, it is now necessary to pass a written exam, which includes questions related to road signs, in order to receive a drivers license. Moreover, to renew your license you must take a vision exam which is based entirely on road signs.

OBJECTIVES

The students will be able to:

1. identify commonly used road signs.
2. match road signs with their shapes or verbal description.
3. define and spell, as appropriate, the following vocabulary words.
   - circle, triangle, rectangle, diamond, pentagon, octagon, yield, stop, speed, limit, railroad, curves

MATERIALS

- Book: Signs by Tana Hoban
- Chart paper
- Markers
- Paper – worksheet

ACTIVITY

1. Have the students name road signs that they are familiar with. Use chart paper to list these signs.

2. Read the book <u>Signs</u>, by Tana Hoban, and compare the list of signs on the chart paper with those mentioned in the book. Add to the list on the chart paper as necessary.

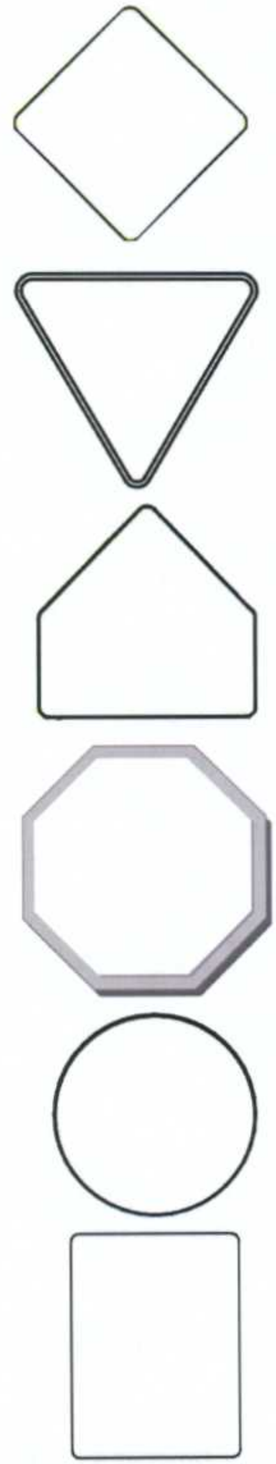
3. Hand out the sheet of road signs included with this lesson. Have the students carefully study the sheet and match the signs and shapes. For older students have them match the signs with the word describing the shape.

4. For an extension to this activity, give the students a piece of paper and allow them to draw and color a road sign of their choice.

5. As an alternative, have them pick a shape out of a hat or a box and then draw a road sign that corresponds to that shape. For example, if a triangle is picked, the student then draws a triangle and colors it like a yield sign.

6. Display all the road signs, pictures and drawings, around the room.

Draw a line connecting the signs to the shapes.



Draw a line connecting the signs to the names of the shapes.

Circle

Diamond

Pentagon

Triangle

Hexagon

Rectangle

THROUGH THICK AND THIN

K-2 Transportation **Lesson 3**

OVERVIEW

When a road is built it generally has been designed to support the weight of semi tractor-trailers. Relatively speaking, the weight of a car is very small (about 5,000 lb) compared with that of a semi (about 72,000 lb). This large weight requires that the roadway pavement be rather thick. In many cases, an asphalt highway pavement will be on the order of 24 inches thick, and sometimes more. If the pavement is too thin, a truck will literally crush the pavement. This significantly shortens the life expectancy of the pavement. If the damage is serious enough it can contribute to an automobile accident as a driver can lose control on the rough terrain. Thus, an engineer must balance the cost associated with a thick pavement with the longevity and safety of a thinner pavement.

OBJECTIVES

The students will be able to:

1. understand that a pavement must be thick enough to support the weight of the vehicles which cross it.
2. understand that engineering design requires several factors be considered before a final solution is determined
3. define and spell, as appropriate, the following vocabulary words.
    - asphalt, thickness, pavement, crush

MATERIALS

- ¼ Sheet cake pan
- Soil (not potting soil)
- Toy car
- Large spoon
- Plastic cup
- Paper of three different thickness, consider notebook paper, craft paper, poster board paper.

ACTIVITY

1. Divide the students into groups of a manageable size.
2. Give each group a cake pan, supply of soil, one large spoon, three pieces of paper, a toy car, and a plastic cup to compact the soil.
3. Have the students place the soil in the pan until it is about one-half full. The soil represents the ground on which a pavement is built. Roughly level the soil in the pan with the spoon. See Figure 1.
4. Using the plastic cup, compact all the soil in the pan. If the soil compacts easily, it may be necessary to add more soil to the pan. Compact any additional soil. After all the compaction is complete, the soil should be relatively level.
5. Next, place the notebook paper on top of the soil. Have one student in each group "drive" their car across the paper. While the car is being "driven" across the paper, have the group observe what happens to the paper. See Figure 2.

   The notebook paper should crinkle noticeably as the car is driven across it.
6. Remove the notebook paper from the pan and use the plastic cup to compact any soil that was disturbed in the previous step. Have the students take turns compacting the soil and "driving" the car.
7. Place the craft paper in the pan and once again "drive" the car across the paper. Observe what occurs this time.

   The craft paper should not deform as much as the notebook paper but should show some signs of being crinkled.
8. Again, re-compact the soil, place the poster board on the soil, and "drive" the car across the paper. See Figure 3.

   The poster board should exhibit little crinkling.
9. Set the sheets of paper side-by-side so that the members of each group can clearly see the amount of crinkling that occurred with each sheet. See Figure 4.

Figure 1

Figure 2

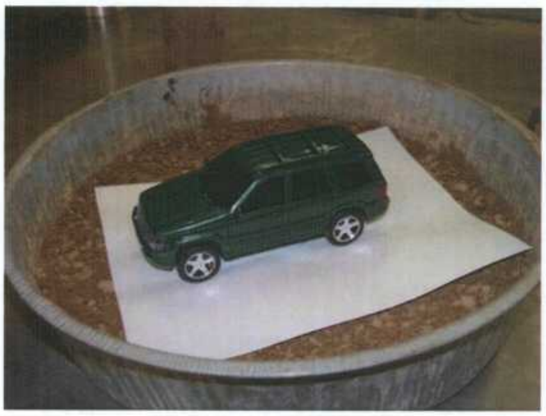


Figure 3

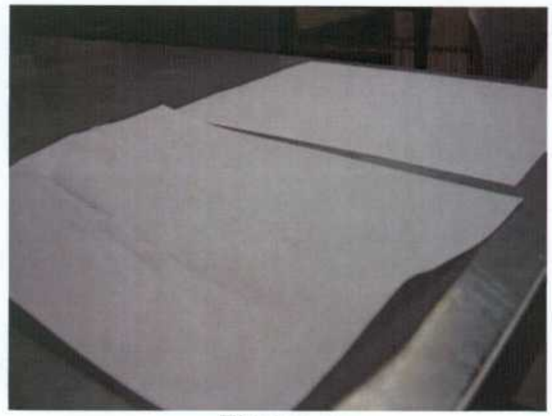


Figure 4

WHICH WAY DO I GO?

3-5 Transportation **Lesson 1**

OVERVIEW

As you drive around any city, you discover that some intersections have Stop signs while others have traffic signals. Some intersections have separate lanes for left or right hand turns while others do not. Intersections with traffic signals may, or may not, have an arrow for those making left hand turns. And finally, some intersections have technology to sense the presence of a vehicle and will then change the light on the traffic signal while others rely on a set timing pattern.

How are the decisions made regarding whether an intersection has a light or Stop sign, turn lanes, arrows for left hand turns, or sensors? The answer comes down to analyzing the traffic pattern at the intersection. In other words, which way are drivers traveling BEFORE any change is made to the traffic control at the intersection? If the flow of the traffic is sufficient, then a signal, turn lane, arrow, or sensor might be installed. Analyzing existing traffic patterns requires that each vehicle maneuver be counted either manually, or by a mechanical means, at the intersection. This data is then reviewed to determine if the traffic pattern warrants upgrades to the intersection.

OBJECTIVES

The students will be able to:

1. collect field data and perform a simple analysis on the data
2. make a simple column chart
3. discuss the procedures involved in determining how to improve the traffic flow at an intersection
4. define and spell, as appropriate, the following vocabulary words
   - intersection, maneuver, analyze, mechanical

MATERIALS

- Orange colored vests for the students
- Traffic counting sheet provided in Figure 1
- Clip board
- Pen, pencil, markers
- Graph paper or graphing software like MS Excel

ACTIVITY

This activity requires that the students be positioned at the corners of an intersection. Therefore, it will be necessary to identify a near by (safe) intersection, have good weather conditions, obtain permission from parents, have an orange safety vest for each student, and parental aides at each intersection. Also, this activity will require two class periods, and possibly a homework assignment to complete.

1. Divide the students into small groups of a manageable size.
2. Provide each student with a clip board, data sheet, and an orange vest. Each group should also be assigned a parental aide. Explain that each student will observe a specific direction of traffic at a specific intersection, and that they will use the data sheet to record the maneuvers of the vehicles at that intersection.
3. Inform each student as to their intersection and direction assignment.
4. Before leaving the classroom, have each student complete the top portion of the data sheet. Have them use the sketch of an intersection to identify which direction is North as well as the names of the intersection streets. Also, have them draw lines on the sketch to indicate the maneuvers they will be observing and recording.
5. For each vehicle maneuver, have the students place a slash through the next number in the sequence provided.
6. When the time available (at least 30 minutes is preferable) for collecting data has ended have the students return to the classroom and turn in their data sheets.
7. To analyze the data, have the students find the total of all maneuvers for their direction of traffic. Then, have the students calculate the percent of maneuvers representing a left turn, right turn, and going straight. The sum of these percentages must total 100%.

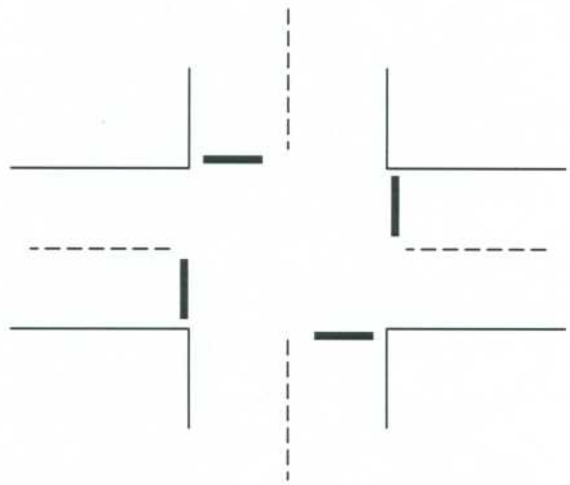
8. Have each student create a column chart to present their percentage data. For each intersection, combine the charts for the four directions together, copy, and provide a copy to each student.
9. Have the students work in their groups to determine if the stop signs at the intersection (if there are signs) should be replaced with traffic signals. Also, should there be turning lanes, sensors, etc. These decisions are generally based on the volume (percentage) of traffic traveling through an intersection.

TRAFFIC COUNT DATA SHEET

Data at the Intersection of ____________________ and ____________________

Data on this sheet is for traffic entering the intersection from the

N S E W NW NE SW SE (circle one)



Date: _______________ Start Time: ________ End Time: _______

Number of vehicles that turn LEFT

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55
56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

Number of vehicles that go STRAIGHT

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55
56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

Number of vehicles that turn RIGHT

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55
56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

VITAL SIGNS

3-5 Transportation **Lesson 2**

OVERVIEW

Key features of a safe transportation system include consistency, regularity, and uniformity. The driver must never be "taken by surprise" as they travel on a city street, state highway, or interstate highway. One aspect of the transportation system where consistency, regularity, and uniformity are evident is with traffic signs and pavement markings.

Color and shape are consistent features of traffic signs. See Figure 1. For example, regulatory signs are generally rectangular in shape and black and white in color, such as a speed limit or one way sign. Warning signs will typically be yellow and black with a diamond shape. Tourist information appears on brown and white colored signs.

Pavement markings are similar to signs as there is meaning to the color and form of the marking. A common saying is "white on your right" which means that white lines separate traffic lanes that are moving in the same direction and mark the right edge of the road. Thus, a white line should be located to the right of the driver. Yellow lines separate lanes where traffic is moving in different directions and marks the left edge of the road. Dashed and solid lines also provide information to the driver. A dashed line on your side means that you may cross over the line while a solid line indicates that you cannot cross the line. You will see combinations of dashed and solid lines on state highways to denote areas where passing is, or is not, permitted.

The following two web sites provide information on highway sign requirements as well as images of many different signs from around the world.

http://mutcd.fhwa.dot.gov/signs/
http://www.ugcs.caltech.edu/~jlin/signs/

OBJECTIVES

The students will be able to:

1. realize the importance of road signs in their community.
2. identify types of road signs.

3. define and spell, as appropriate, the following vocabulary words
    - diamond, rectangle, triangle, regulatory, construction, warning, information

MATERIALS

- Images of signs and markings found in Figure 2
- Pens, pencils, markers
- Poster board
- Scissors

ACTIVITY

1. Divide the class in to groups of a manageable size.
2. Give each group a sheet of the signs provided in Figure 2. Have the students cut the images out of the paper and place them in a pile in front of the group of students.
3. Without providing any prior insight on shapes and colors, ask the groups to combine similar signs together. Tell the groups that they are to establish their own criteria for what it means to be similar. Further, with each group of signs they create, the students must prepare a one or two sentence explanation of how the signs in the group are similar.
4. Have each group create a poster with their groupings and explanations.
5. After the posters have been completed, present to the students the government established criteria found in Figure 1. Be sure to comment on the need for consistency, regularity, and uniformity with signs on our roadways.

Color	Shape	Category	Examples
RED	Various	Regulatory	Stop, Yield, Wrong Way
ORANGE	Diamond	Construction	Work Zone, Merge
YELLOW	Diamond, triangle	Warning	Railroad and other Crossing
BROWN	Rectangle	Guide and information	Park, Monument, Marker

Figure 1

Figure 2

Figure 1 Continued

I THINK I CAN, I THINK I CAN, I KNOW I CAN

Transportation 3-5 **Lesson 3**

OVERVIEW

Trails forged by early settlers, and then later by the railroad, snake back and forth through steep terrain. This is because it is too demanding to cross directly over an incline. A simpler approach is to travel perpendicular to the incline, moving up the hill little by little. It may take longer to get to the top, but in the end, less energy has been expended.

While automotive and small truck engines can produce a large amount of power, and thus can attack an incline head-on, larger vehicles like tractor-trailers still struggle to ascend a tall hill or mountain. Occasionally, a special truck lane is constructed on the right-hand side of a highway to accommodate the slower moving trailers. More often, the slope of the highway is reduced during the design process to an angle which will permit trailers to proceed up a hill with a minimal drop-off in speed. In fact, the government has placed limits on the inclination of interstate highways in order to avoid the traffic flow problems caused by slow moving trucks.

OBJECTIVES

The students will be able to:

1. determine the maximum slope a toy "vehicle" can ascend
2. explain the relationship between the slope of a highway and a vehicle's, particularly a tracker-trailer, ability to ascend the slope
3. define and spell, as appropriate, the following vocabulary words
   - ascend, terrain, perpendicular, automotive, inclination

MATERIALS

- Pre-cut and sanded wood from a local home center
- Finish nails
- Hammer
- Toy wind-up "vehicle"

- Block

ACTIVITY

1. Using the hammer and finish nails, attach the side rail pieces to the roadway surface piece.
2. Place the block under one end of the roadway built in Step 1.
3. Wind-up the "vehicle", place the vehicle at the bottom of the incline, and release the vehicle. Assess whether the vehicle is able to climb the hill.
4. Repeat Steps 2 and 3, placing the block at different locations thus creating different inclinations. Find the maximum angle that the vehicle is able to climb.
5. This activity can be repeated with different types of "vehicles".
6. This activity can also be repeated by placing different materials on the highway surface. For example, the highway surface could be dampened by water to depict a rain storm. Non-skid drawer sheets could be used as could pieces of carpet remnant.

YOU CAN'T GET THERE FROM HERE

6 - 8 Transportation **Lesson 1**

OVERVIEW

A growing field within Transportation (and Industrial) Engineering is Logistics. Logistics refers to the development of a plan to complete a task. In the case of transportation, logistics refers to the plan for moving goods from one location to another. To move goods in an affordable and expeditious manner, shippers will consider moving items by air, train, truck, and water. Each of these means of transportation is referred to as a mode. Multi-mode transportation indicates that an item was shipped by more than one mode. For example, a package sent by overnight mail will be picked up and delivered to a local airport by a truck. It will then be sent to an intermediate location by air. It is then transported by truck to the recipient. This delivery used two modes, truck and air, to move a package. This is a simple example of logistics and transportation. Larger sized items, greater distances to travel, and time constraints on delivery will all increase the complexity of moving goods throughout the world.

OBJECTIVES

The students will be able to:

1. use different modes of transportation to plan the movement of an object from an origin to a destination.
2. define and spell, as appropriate, the following vocabulary words
    - logistics, industrial engineering, mode

MATERIALS

- Notebook paper
- Colored pens, pencils, markers, etc
- Several black and white copies of US and European maps

ACTIVITY

This activity can be extended over a number of class periods. It could also be presented as a homework assignment.

1. Divide the students into small groups of a manageable size.
2. Give each group a list of specific cargo that must be moved from one location to another. Examples of possible cargo and destinations might include:
   - Ship a specially designed piece of construction equipment, which is too heavy to be sent by aircraft, from your city to Oslo, Norway. The equipment is to originate from the manufacturer's facility and is to be delivered to a construction site in Oslo.
   - Ship a memory chip for a computer from a chip producer in San Francisco, California to a retail store in New York City. The chip must arrive in New York City within two business days.
   - Ship 1000 candy bars from a specialty shop in Verona, Wisconsin to a residence in Bethlehem, Pennsylvania.

   In each case, the group is to identify what they believe to be the "best" means to transport the items to their respective destinations. "Best" could mean least costly, quickest, shortest route, fewest number of transfers, or some other criteria.
3. For each item being shipped, have the students draw their proposed route on a separate map. Use a different color to represent each mode of transportation used to ship the item. Further, each map should be accompanied by a brief report explaining the modes of transportation used, the time required to ship the item, the justification for why the selected route is the "best", and any other information requested by the instructor.
4. Have each group present the results of their investigation and planning to the other members of the class. Discuss the pros and cons of a few representative plans.

I CAN SEE CLEARLY NOW

6 - 8 TRANSPORTATION   Lesson 2

OVERVIEW

Driving on state and county highways can be a very demanding task, especially when the highway is a two lane road. In addition to oncoming traffic, vehicles are moving at a relatively high rate of speed. There are numerous entry and exit points along the highway, and there are often several obstacles to your visibility. Visual obstacles include rolling terrain as well as trees, shops, and signs along the side of the road. Driving at night requires even more concentration as distance is difficult to judge and not all obstacles are lighted.

As an aide for the driver, state and county highway departments establish "no passing zones" in areas where visibility is limited. Areas where passing is prohibited are always marked by double yellow lines (See Figure 1) along the centerline of the roadway. Some states also post "No Passing" signs (See Figure 2) along the left hand shoulder at the start of no passing zones.

Whether passing is permitted or not is based on specific criteria. A driver, whose eyes are assumed to be roughly 4 feet above the roadway, must be able to see an object that is also 4 feet tall and is resting on the roadway. If the distance between the driver and the object is sufficiently long, then passing is permitted. If the distance is too short, then passing is prohibited. The distance is a function of the speed at which a vehicle is moving. Once the passing and no passing areas have been identified, the highway department then marks the roadway accordingly.

OBJECTIVES

The students will be able to:

1. identify distances along a sidewalk where "passing" would be permitted or prohibited.

MATERIALS

- Two adjustable shower curtain rods, or window curtain rods, that will extend to at least 4 feet

- A 200 foot length of string, twine, yarn or other similar material
- Dark colored sidewalk chalk

ACTIVITY

To get the most out of this activity, find a sidewalk near your school which has noticeable changes in elevation. This activity is not suited to level ground. Inform the students that they are to determine where along the sidewalk they could safely pass a pedestrian if they were riding their bicycle. They would want to be able to see far enough ahead, so as they went around the pedestrian, they did not run into an oncoming cyclist.

1. Divide the students into groups of three. One student will take the sidewalk chalk and use it to mark "no passing zones" on the sidewalk.
2. Have another student extend both shower curtain/window curtain rods to 4 feet. Tie one end of the string/twine/yarn to each rod. See Figure 3. Position the string so that it is 2 feet off the ground. One rod represents the bicyclist (B1) wishing to pass the pedestrian while the other rod represents the oncoming bicyclist (B2).
3. Have all three students move to the sidewalk.
4. Student B1 should select a position to start and then stand at that location with the bottom of the rod resting on the sidewalk.
5. Student B2 should walk along the sidewalk, away from B1, until the string becomes taut. This student should also place the bottom of the rod on the sidewalk, as shown in Figure 4.
6. The third student, the one with the chalk, should then confirm that the string between the rods is either completely off the sidewalk or is touching the sidewalk at one or more locations. The string will touch the sidewalk in areas where there is a change in elevation between the ends of the string.
7. If the string is not touching the sidewalk, then students B1 and B2 should move in unison, keeping the sting taut, along the sidewalk until the string touches the sidewalk.
8. If the string touches the sidewalk, this is an indicator of a lack of sufficient visibility over a 200 foot distance. See Figure 5.The position of student B1 when the string touches the sidewalk is then the START of the no passing zone. The point is then marked with the sidewalk chalk.
9. Students B1 and B2 should again move until the string is no longer touching the sidewalk. The location of student B2 when the sting ceases to touch the sidewalk represents the END of the no passing zone.

10. A chalk line can then be drawn between the starting and end points of the "no passing zone".
11. Have the students continue along the sidewalk for some specified, practical distance.
12. As much as possible, have each group of students work with a different portion of the sidewalk, or a different sidewalk altogether.

Figure 1

Figure 2

Figure 3

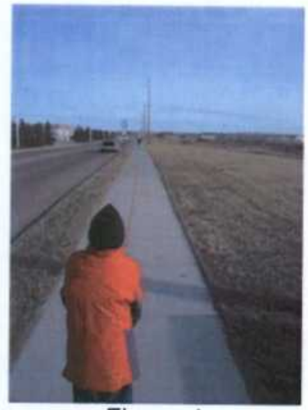


Figure 4

Figure 5

ITS TIME TO CHECK YOUR SPEED!

6 - 8 TRANSPORTATION Lesson 3

OVERVIEW

In some areas of the country you can find very wide white lines painted on, or along-side, a roadway. These lines are positioned perpendicular to the direction of traffic. The purpose of these lines is to serve as start and end points for determining the speed of a vehicle, generally from an aircraft. An individual in the aircraft will measure the time used by a vehicle to travel from the start to the end point. Knowing the distance between the start and end points, the speed of the vehicle can be computed in miles per hour and compared with the posted speed limit. If the computed speed exceeds the posted limit, the crew on the aircraft notifies a police officer on the ground, who then issues the driver of the vehicle a citation for speeding. Therefore, if you encounter large white lines, perpendicular to the direction of traffic, painted on a roadway, it would be wise to maintain the posted speed limit.

OBJECTIVES

The students will be able to:

1. compute the speed of a vehicle.
2. define the following vocabulary words.
    - perpendicular

MATERIALS

- Bicycles
- Sidewalk chalk, scrap wood, or other marking device
- 50 foot measuring tape
- Stop watch or watch with a second hand
- Paper
- Pencil/pen
- Calculator

ACTIVITY

This activity involves determining the speed of a vehicle. The vehicle could be a passenger car, truck, or even a bicycle ridden on the sidewalk by the students in your class. The last example is the approach that will be taken below.

1. Find a safe area in, or around, the school parking lot.
2. Identify, with the chalk, wood, or other item, a point on the sidewalk and label it as the "Start" line. See Figure 1.
3. Use the tape measure to establish a second line, the "Finish" line, 50 feet from the Start line. Mark this line on the sidewalk.
4. Have each student take a turn riding a bike across the 50 foot distance. See Figures 1 and 2. Have one student (Student S) stand at the start line while another is sitting on the bicycle (Student B). Have another student (Student F) at the finish line holding a stop watch. You stand at the finish line as well and record the elapsed time for each student in the class.
5. Student S confirms with Student B that they are ready to go. Student S raises his/her hand to indicate to Student F that the bike rider is ready. Student S then drops his/her hand. With that, Student B begins to ride toward the finish line and Student F starts the stopwatch.
6. When the front tire of the bicycle touches the finish line, Student F stops the stopwatch. See Figure 3. Then record the elapsed time, in seconds. Repeat this process at least once for each student in the class. You might consider having each student ride 2 or 3 times so that an average time and speed can be computed.
7. Once all times have been recorded, return to the classroom to compute the students' speeds in miles per hour. This is computed as follows.

   50 feet / X seconds = (50/X) ft/sec

   [(50/X) ft/sec] [1 mile/5280 feet] [3600 sec/1 hour] = **(50/X) (3600/5280)** mph

   You can increase the complexity of this activity by requiring the students to establish the factor for converting ft/sec to m/hr.
8. If more than one time was recorded for a student, you can either average the elapsed times and compute a speed, or average the computed speeds based on each individual's elapsed time.
9. Ask the students to identify other vehicles whose speed can be computed in this manner.
10. Ask the students to identify conditions under which this process would not work for determining the speed of a vehicle. For example, it would not be possible to

use this process at night as the start and finish lines may not be visible from an aircraft.


Figure 1


Figure 2


Figure 3

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

HOME

SURVEYING technology

K to 2nd Grade

Where's The Beef ?
My Guess Is As Good As Yours
My Foot Isn't Twelve Inches Long

3rd to 5th Grade

Let Me Level With You
You've Got To Keep Up The Pace
In The Eye Of The Beholder

6th to 8th Grade

I'm Watching You From A Distance
You Take The High Road
Are You A Standout In Your Field?

Civil Engineering - A Bridge to the Future

WHERE'S THE BEEF?

K-2 SURVEYING **Lesson 1**

OVERVIEW

A critical part of surveying is being able to describe an object in such a manner that there is no question as to its location, shape, and dimensions. This is a far more difficult task than it appears. This is because most of the terms we typically use to describe an object are relative in nature. In order to reduce the potential for confusion and errors, surveyors must use terminology that is more specific, or absolute, so there is only one meaning for any given term. For example, left is a relative term where as West is an absolute term. Without absolute directional terms, it would be very difficult to determine the location of a home, the boundaries of a yard, the end support for a bridge, or the column placement in a building.

OBJECTIVES

The students will be able to:

1. verbalize directions.
2. define and spell, as appropriate, the following vocabulary words.
   - above, below, behind, in front, next to, North, South, East, West

MATERIALS

- Notebook paper
- Pencils

ACTIVITY

1. Play a game similar to "I Spy" with the students. However, use directional words such as near, under, above, next to, in front of, behind, etc to explain what you are looking at.
2. Pick an object in the room and ask the students to try and locate the object using only questions. Have the students take turns asking questions such as, "Is it near.....?", "Is it under .....?", "Is it next to .....?"

3. You as the teacher could also describe the object to the students using directional words and the students can guess the object. You may want to model the activity for the students and then allow them to try being the "teacher".
4. Next, use absolute terms such as North, South, East, and West for the "I Spy" game. Place signs on the walls of your classroom to help the students learn these four primary directions.
5. As appropriate, have the students use relative and absolute terms to describe the location of an object in the classroom on a piece of notebook paper. Collect the descriptions and then hand them out to other students. Have the students try to find the object whose location is described on the paper.
6. After the activity, discuss with the students whether they thought it was easier to use relative or absolute terms to describe the location of an item in the classroom.

MY GUESS IS AS GOOD AS YOURS

K-2 SURVEYING **Lesson 2**

OVERVIEW

Whenever possible, an engineer would prefer to know the exact distance between two points or the exact dimension of an object. However, it is often difficult to obtain exact measurements. This is because an obstacle of some sort often exists along the path of interest. An obstacle could be an existing structure, a deep valley, or a steep incline. The use of sophisticated equipment, such as a Global Positioning System (GPS), can allow you to overcome an obstacle, but at a considerable expense. A quick, simple, and inexpensive alternative is to estimate a distance first and then obtain an more accurate measure at some point in the future.

OBJECTIVES

The students will be able to:

1. understand the difference between an exact and estimated measurement.
2. use at least one method to estimate a distance.
3. define and spell, as appropriate, the following vocabulary words.
    - inches, feet, ruler, measure, estimate, exact

MATERIALS

- Chart paper
- Markers
- Ruler or tape measure
- String

ACTIVITY

1. Discuss the difference between an exact measurement and an estimated measurement. To aid this discussion, begin by identifying two points in the classroom. It would be preferable to have a desk or two located along

the path between these points. Ask the students how they might go about measuring the distance between the two points.

2. List the suggestions on the chart paper. Talk about the pros and cons associated with each suggestion. If it is suggested that the desks be moved before the measurement is taken, ask the students how they would proceed if they could not move anything between the points. Again, list the suggestions on the chart paper.
3. Divide the students into groups of a manageable size. Assign each group pairs of points in the classroom, or around the school, that they are to measure the distance between. You can have the groups obtain exact measures, estimates, or both for the assigned points.
4. There are several techniques which can be used to estimate a distance. A few suggested techniques are presented below. You can have each group use the same technique or have different groups use different methods.
    a. If the floor in the classroom is a laminate tile, the students can count the number of tiles between the two points. This technique is less accurate if the line between the points cuts diagonally across the tiles. This problem is addressed below. If you know the number of tiles and the length of any one tile, you can find the total length between the points.
    b. A slight alternative to the above is to create a right triangle with the line of interest being the long side of the triangle. This is more sophisticated than what a k-2 student can understand, but with your help this issue can be overcome. Have the students count the number of tiles along the two shorter sides of the triangle. You can then use the Pythagorean theory to find the length of the line. See Figure 1.
    c. Take a string and "thread" it through and around any desks or tables that are in the way. Mark the beginning and end points on the string with a marker. Gather up the string and lay it on the ground in an unobstructed area and measure the length of the string.
    d. First, have the students walk along a line of known length. The length of this line can be predetermined with a tape measure. Have the students count the number of steps it takes for them to walk the full length of the line. Divide the length of the line by the number of steps each student takes. This is then the average length of a step for that student. The student can then walk along some other line, count the number of their steps, and estimate the length of that line.
5. After each group has had an opportunity to measure a distance, record these measurements on the chart paper. Discuss with the students that any differences are a result of the estimation process.

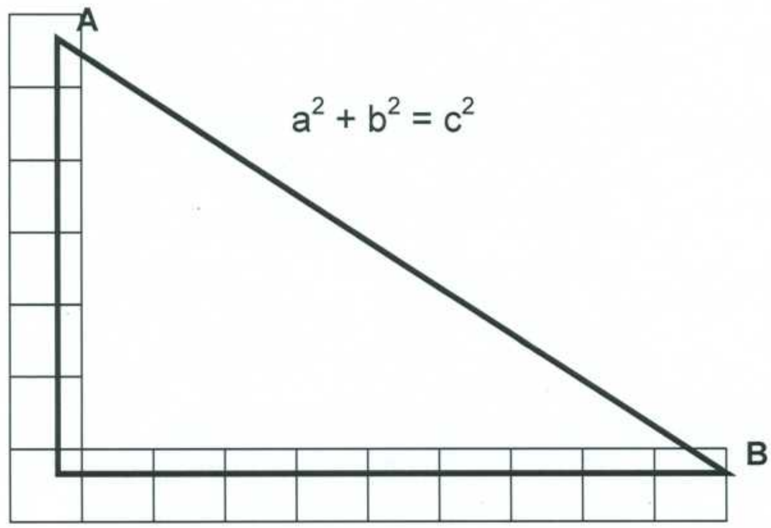


Figure 1

MY FOOT ISN'T TWELVE INCHES LONG

K-2 SURVEYING **Lesson 3**

OVERVIEW

It is very common to encounter a surveyor whenever you purchase, or re-finance, a home. This is because many mortgage lenders want to make sure they have the proper description of the property and to insure that a structure owned by someone else is not located on your property. During the survey, the length and direction of each side of the yard is determined. Generally a stake, with a ribbon, is placed at each corner, or directional change, on the property. Often, a steel rod is hammered into the ground to provide a more permanent indicator of a corner or change in direction. Once these measurements and directions are recorded, the surveyor can create a map of the property. This map can be used later to help determine the location of a fence, a pool, a storage building, or other outside fixture.

OBJECTIVES

The students will be able to:

1. measure distances and the size of objects.
2. draw a simple map of a room.
3. define and spell, as appropriate, the following vocabulary words.
    - surveying, inches, feet, yard, measure, vertical, horizontal, scale, map

MATERIALS

- Bulletin board paper
- Notebook paper
- Pencils and markers
- Yard stick, rulers, tape measures or other such devices

ACTIVITY

1. Ask the students for their thoughts on why we need and use maps. Determine how many of the students have drawn a map before. With help from the students, create a list of different types of maps. Responses might include a treasure map, road map, weather map, etc.
2. Work with the students to create a map of your classroom. The map should include the location of the walls, windows, doors, and closets along the perimeter. Also include the location of a few desks, fixtures, or other items in the room.
3. Demonstrate how to use a ruler, yard stick, or tape measure to determine a distance.
4. Divide the class into small groups of a manageable size. Give each group a tool with which to take measurements.
5. Assign each group an area of the classroom as well as a few items, desks, windows, doors, etc. to measure. Have the group record their measurement on a piece of notebook paper.
6. After all of the measurement have been recorded and turned in, begin to draw a map of the classroom on the large sized bulletin board paper. It will be necessary to draw a scale version of the classroom. Thus, it will be helpful to establish a reasonable scale prior to creating the map.
7. The map can be displayed in the classroom after the project is completed. Items can be added to the map as the school year progresses.

ADDITIONAL ACTIVITY

Have the students take measurements of a room in their home, draw a map of the room, and then bring the map to class to present to their fellow students.

LET ME LEVEL WITH YOU

3-5 SURVEYING **Lesson 1**

OVERVIEW

When planning any construction project, it is necessary to determine horizontal distances and vertical elevations within the area of the project. To determine the elevation of any point on, or above, the ground requires the use of a surveying instrument known as a level and a level rod. See Figures 1 and 2. A level provides a horizontal line of sight between two points. The level is positioned over one point while the level rod is located at the other point. The lens on the level allows you to read a measurement off the level rod. This measurement is then used to compute the elevation at the location of the level rod. When these elevations are combined with horizontal distances, it is possible to prepare a topographic map. Such a map depicts the ups and downs of the earth's surface. With this information, a contractor can determine where soil must be removed and where low areas need to be filled in.

OBJECTIVES

The students will be able to:

1. use a very simple level and level rod
2. compute the elevation of a point in their classroom
3. define and spell, as appropriate, the following vocabulary words
    - elevation, surveying, instrument, topography, topographic, measurement

MATERIALS

- The tube from a roll of paper towels
- Notebook paper
- Tape
- Yard stick and tape measure
- Line level from a hardware store, See Figure 3

ACTIVITY

1. Divide the students into groups of three. Student A will use the make-shift level, Student B will watch the line level, while Student C will hold the yard stick.
2. Cut out a small piece of notebook paper and tape it to the tube so that it covers only the lower half of the tube. See Figure 4. This paper will help Student A read a distance off the yard stick.
3. Next, tape the line level on to the top of the tube. The line level will insure that the paper towel tube is held level while Student A looks through the tube. Student B will watch the bubble in the level and inform Student A when the tube must be raised or lowered so that it remains level.
4. Have Student A stand in one place in the classroom. With the tape measure, determine the distance from the floor to the top of the notebook paper taped to the tube. Student B will record this distance. This distance will be used in the calculations to find the elevation of other points in the room.
5. Have Student C place the yard stick on an object somewhere in the classroom. This could be a desktop, counter, chair, etc. Student A will then look through the level and read the value off the yard stick. Student B can record this measurement along with the location of the yard stick.
6. Repeat Step 5 for several points around the room. Also, rotate the role that Student's A, B, and C have in the surveying process. When a new student uses the level it will be necessary to repeat Step 4.
7. To determine the elevation of a point, perform the following computation.

   Elevation = Dimension from Step 4 - Reading from Step 5
8. Have some groups measure the elevation of the same point to see how close their results are.

Figure 1

Figure 2

Figure 3

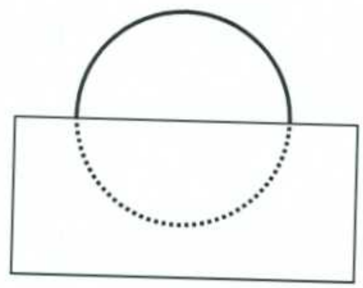


Figure 4

YOU'VE GOT TO KEEP UP THE PACE

3-5 SURVEYING **Lesson 2**

OVERVIEW

Unless you have access to some expensive surveying equipment, there will be several occasions where it is either not possible, or not practical, to get an exact measurement of a horizontal distance. In these cases, the best you can do, until a surveyor takes over, is to estimate the distance as accurately as possible. One of the easiest ways to estimate a horizontal distance is to "pace" the distance. Pace means to walk along the line of interest and count the number of steps required to get from Point A to B. If you know the length of a single step, or pace, you then multiply the number of paces between points by the length of one pace and you will have your estimate. The accuracy of your estimate will improve with the accuracy of your pace measurement, the consistency of your pace, and how level the terrain is. Pacing a distance is a quick, inexpensive, and relatively accurate means for estimating a distance.

OBJECTIVES

The students will be able to:

1. determine the length of their pace
2. use their pace length to estimate a long distance
3. use estimated distances to prepare a simple map
4. define and spell, as appropriate, the following vocabulary words
   - surveying, surveyor, survey, equipment, measurement, practical, estimate, consistency

MATERIALS

- Masking tape
- Tape measure
- Notebook paper
- Pen, pencil, marker
- Notebook paper

- Clip board

ACTIVITY

1. Using the masking tape and tape measure, place two marks on the floor in the classroom or hallway which are 10 feet apart.
2. Give each student a clip board with notebook paper so that they can record their results for this project.
3. Have each student walk from end to end of this line, counting the number of steps each takes. Count the number of steps to the nearest ½ step. Thus, if the final full step takes a student beyond the end of the ten foot line, then count the final step to the nearest ½ step. Therefore, a student will either have taken X steps, X.5 steps, or X+1 steps, where X is any number.
4. Each student should repeat Step 2 at least three times and then average their three results for a final value, again taken to the nearest ½ step.
5. Establish a course somewhere on school grounds. This could be along the exterior of the building, from one room to another inside the building, between buildings, etc. Have each student pace the entire course, keeping track of there paces for each segment of the course.
6. Once each student has completed pacing the course, have the students prepare a map of the course. Have them use a scale similar to 1 unit on the paper = 1 pace (or 2 paces, etc) of actual measure.
7. The students should make notes on the map where there were inclines or depressions that may adversely effect their estimated distance.

IN THE EYE OF THE BEHOLDER

3-5 SURVEYING **Lesson 3**

OVERVIEW

Whenever possible, an engineer would prefer to know the exact dimension of an object. An exact length can be difficult to measure when a vertical dimension is desired. This is because it may not be possible, or practical, to access the top of the object. Thus, with vertical dimensions it may be necessary at times to rely on estimated dimensions as opposed to more accurately determined values. When an accurate dimension is required, a surveyor will use a transit to measure the angle between the horizon and the top of the object. A trigonometric equation is then used to compute the vertical dimension.

OBJECTIVES

The students will be able to:

1. make an estimate of a vertical dimension.
2. assess the accuracy of an estimation technique.
3. define and spell, as appropriate, the following vocabulary words
   - measure, accuracy, technique, estimate, surveying, percentage

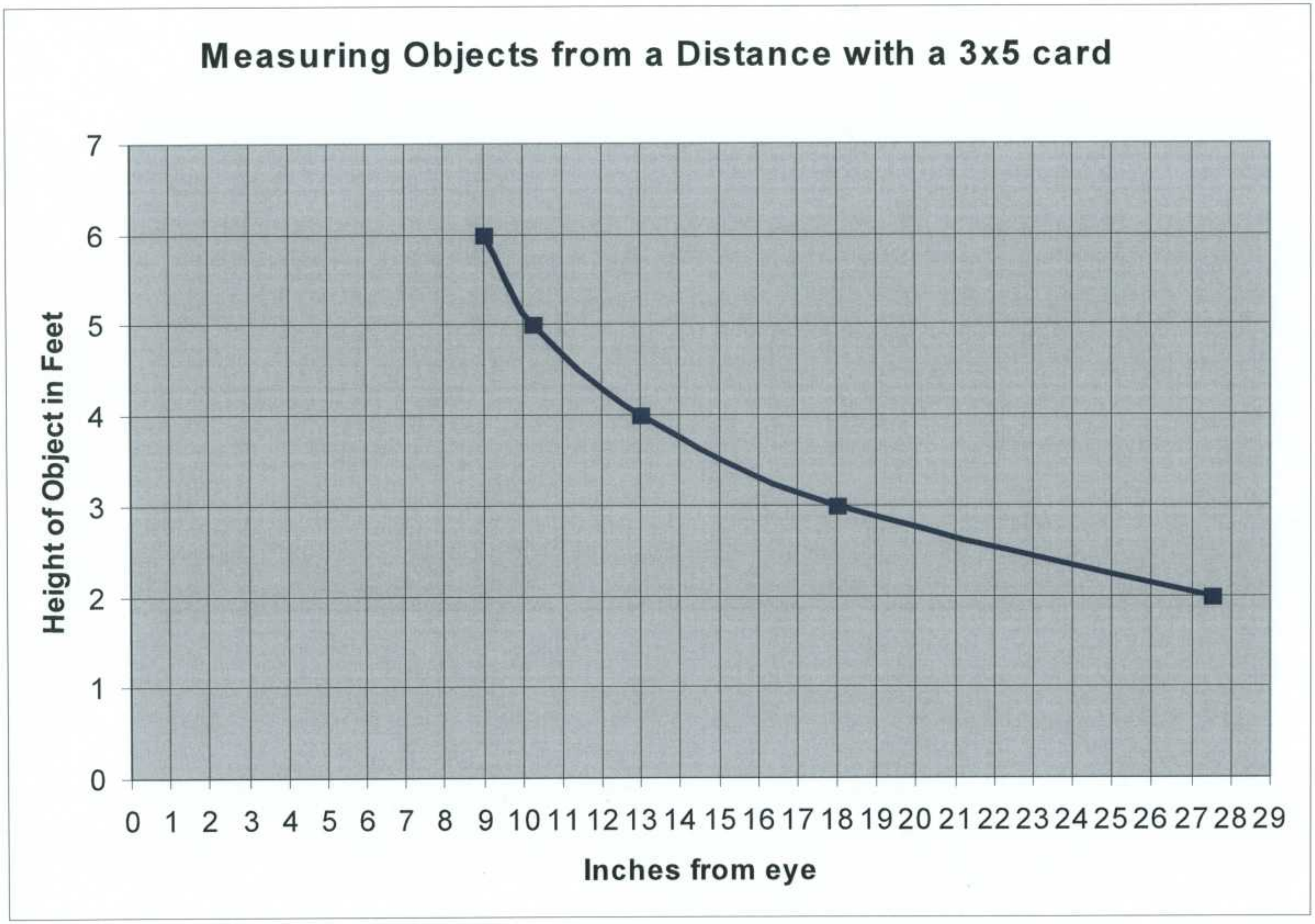
MATERIALS

- Index cards
- Paper
- Masking tape
- Yard sticks (1 per group)
- Chart of known measurements

ACTIVITY

1. Divide the class into small groups of a manageable size.

2. Using the yard stick, have each group measure a 10-foot distances on the floor of the classroom. Use the masking tape to mark the ends of the 10-foot length.
3. Have two students from each group stand at the opposite ends of the 10-foot line. Identify one of these students as Student A and the other as Student B. A third student, Student C, will be assisting with this activity.
4. Have Student A hold a 3" x 5" index card (with the 5 inch length being vertical) up to one eye. With the other eye closed, have Student A move the index card forward and backward until the card appears to be the same height as Student B. In other words, the top of the card aligns with the top of Student B's head while the bottom of the card aligns with the bottom of Student B's feet. Student C should then use a ruler to carefully measure the distance from the vertical edge of the card to Student A's eye. Record this distance in inches.
5. Once each member of the group has had the opportunity to be Student A, B, and C, refer to the chart that is provided in Figure 1 to estimate the height of each student.
6. The students can then stand against the wall and have their height measured more accurately. Compare these heights to the estimated height found by the surveying method.
7. Assess the accuracy of the estimation method. Among all groups, what was the greatest difference between an actual and estimated height? What was the smallest difference? These differences could be presented as percentages.
8. Next, have the students practice the estimation technique by measuring different objects in the classroom (chalkboards, windows, doors, etc). To use the chart provided, it will be necessary that Student A always be 10-feet from the object being measured.



Measuring Objects from a Distance with a 3x5 card
Height of Object in Feet
Inches from eye
0
1
2
3
4
5
6
7
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

Figure 1

I'M WATCHING YOU FROM A DISTANCE

6 - 8 SURVEYING **Lesson 1**

OVERVIEW

While it is very important in engineering that precise measurements be made when planning a project, fabricating a component, or building a structure, there are several occasions where an estimate of a dimension is all that is needed, or all that can be obtained. Surveying is the technology used to precisely measure distances and angles. Surveying requires the use of technically advanced, and often computerized, equipment. Global Positioning Systems, or GPS, is the latest development in surveying technology.

A GPS unit is not always necessary to gather sufficient dimensional information. In these cases, any one of a number of techniques can be employed to estimate a dimension or judge a distance. For example, it is common to hear a distance described as "roughly equal to 2 football fields". The individual making this statement has a sense of the length of a football field and thus can use this knowledge to estimate another distance. In addition to estimating dimensions and distances for engineering purposes, these techniques can prove useful in everyday life.

OBJECTIVES

The students will be able to:

1. apply a simple technique for estimating the size of an object from a distance.
2. define the following vocabulary words
   - dimensional information, surveying, global positioning system, similar triangles

MATERIALS

- 3" x 5" index cards
- Paper for recording data
- 12 inch ruler, 1 per group
- Tape measure

- Masking tape

ACTIVITY

There are two approaches which can be taken with this activity. Option 2 is recommended if there is an interest in highlighting how mathematical principles, such as similar triangles and algebra, have an impact on engineering work.

Option 1

1. With the help of the students, lay out several 10-foot distances on the floor of the classroom. Use the tape measure and masking tape to mark the ends of the distances.
2. Divide the students into groups of a manageable size.
3. Have two students, referred to as Student "A" and Student "B", form a straight line by standing on the masking tape at either end of a 10-foot distance.
4. Have Student "A" hold a 3" x 5" index card, with the 5" distance being the vertical dimension, up to one eye. See Figure 1. With the opposite eye closed, Student "A" is to move the index card forward and backward until the height of the card appears to be the same as the height of Student "B". See Figure 2.
5. Using a ruler, Student "C" then measures the distance from the card to Student "A's" eye. Record this distance in inches.
6. Repeat Steps 3 to 5 until each student in the group has been in the position of Student "B". Once all the members of a group have been "measured" from a distance, refer to Chart 1, provided below, to determine the height of each student.
7. Use the tape measure to "more accurately" measure the height of each student. Have the students stand against a wall in the classroom and have their height measured.
8. Prepare a plot for the class as a whole. The x-axis for this plot shall be the measured (with the tape measure) height of a student. The y-axis shall be the estimated (the 3x5 card techniques) height of a student. For each student, plot their measured vs. estimated heights. If the measured and estimated heights are exactly the same, the plot will be a line at 45°.
9. Quiz the students as to the meaning of a data point which falls below, or above, the 45° line.

10. Select other items in the classroom and have the students use the index card method to estimate a dimension. Again, use Chart 1 to obtain the estimate.

Option 2

1. Have the students create the curve presented in Chart 1. This curve is based on the mathematical principle of similar triangles. In this case the equation is:

$$\frac{\text{distance from eye}}{5\text{ in.}} = \frac{10\text{ ft}}{\text{estimated height (ft)}}$$

or

$$\text{estimated height} = \frac{(5)\text{x}(10)}{\text{distance from eye}}\text{ ft}$$

Have the students prepare a plot where the distance measurement from eye to card ranges from 1.5 inches to 12 inches.

2. As an alternative you can use a different sized index card or distance between students to create a slightly different equation. This could be presented as a homework assignment.

Figure 1

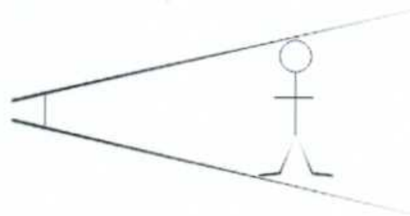


Figure 2

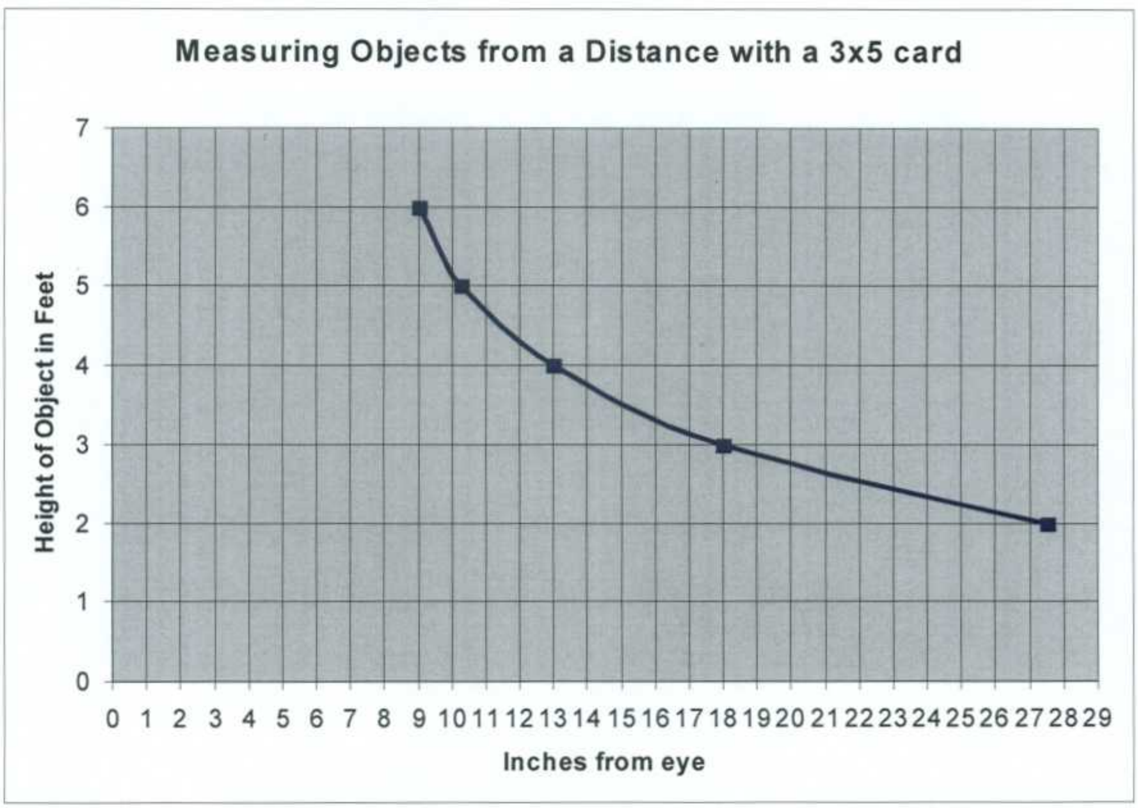


Chart 1

YOU TAKE THE HIGH ROAD

6 - 8 SURVEYING **Lesson 2**

OVERVIEW

One interesting aspect of water is that it will form a level surface if undisturbed. This is easy to confirm if you find a pond where the water is not moving due to wind, swimmers, boaters, and the like. If the surface of the pond is level, then the elevation of the water at the shoreline must be a constant around the entire pond. The line formed at the intersection of the pond surface and the shore is then referred to as a contour line, level line, or line of constant elevation. Another example of a contour line comes from the weather. Weather reporters commonly present maps with bands of color where each color represents a temperature range. The edges of these bands will be lines of constant temperature. Another term used for lines of constant value, whether that is elevation, temperature, or something else, is isoline.

Before construction gets underway on a new building project, a surveyor will be called upon to measure distances, angles, and elevations. This information is then transferred to a map which is later used by other engineers to perform their analysis and design work. The resulting contour map presents three-dimensional data (x and y distances and elevation) on a two-dimensional sheet of paper.

OBJECTIVES

The students will be able to:

1. use simple tools to measure the relative elevation of various points on the ground.
2. define the following vocabulary words.
   - dimensional, elevation, level line, isoline, contour line, contour map

MATERIALS

- An inexpensive pair of binoculars, which could be borrowed from home. If binoculars are not available, the students can use a cardboard tube from an empty roll of paper towels or toilet paper. The binoculars, or tube, will serve as a surveyor's level.

- String
- Masking tape
- Scissors
- A line, or torpedo, level (See Figures 1 and 2)
- A 10, or more, foot tape measure
- Paper and pencil for recording data

ACTIVITY

1. Divide the students into groups of three.
2. Cut 2 pieces of string roughly 4 inches in length.
3. Using the masking tape, secure one piece of string across the front lens of the binoculars, or to one end of the cardboard tube, so that the string is vertical. Tape the other piece of string, also across the lens or opening, so that this string is horizontal. See Figure 3. These pieces of string are then the cross hairs that will be used to measure elevations.
4. When taking a reading with the binoculars or tube, place the line or torpedo level on top of the binoculars, or tube, to insure that it is held level during use.

   Within this lesson plan, the term "level" will now be used to describe either the binoculars or tube with the line or torpedo level on top.

5. Select a "home base" location. One student will stand at this location and use the level to read elevation values.
6. While the home base student holds the level up to their eye, and it is level, have another student use a tape measure to find the distance from the ground to the horizontal string on the level. Record this value. This is the height of the level.
7. The second student then selects a position to stand somewhere else in the area. If the group does not have binoculars, then the second student should not move too far away from the student at home base.
8. The second student should extend the tape measure so that it runs from the ground up and over their head. The first student then looks through the level and reads the value on the tape measure where the horizontal string line intersects the scale on the tape measure. Record this value.
9. Repeat steps 7 and 8 for several other locations in the area. Also, have the students within a group rotate their duties as Home Base, Second, and Third student.

10. To determine the relative elevation of the points where the second student stood requires some mathematical computations. Begin by assuming the ground at Home Base is at 0 feet of elevation. Add to that the height of the level as found in Step 6. This is now the relative elevation of the level. Now subtract the value read off the tape measure by the student at home base. The end result is the relative elevation of the ground at the location where the second student stood.

    For example:

    Height of level = 5.25 feet
    Height value read with level = 4.50 feet

    The elevation at the point in question then is 0 + 5.25 - 4.50 = 0.75 feet or 9 inches

    Since the final result is a positive number, that means that the point in question is ABOVE the elevation of Home Base. If the result were negative, then the other point is BELOW the elevation of Home Base.

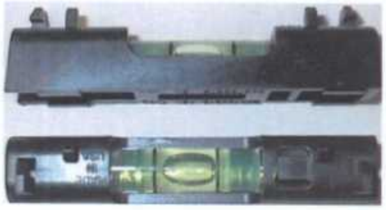


Figure 1

Figure 2

Figure 3

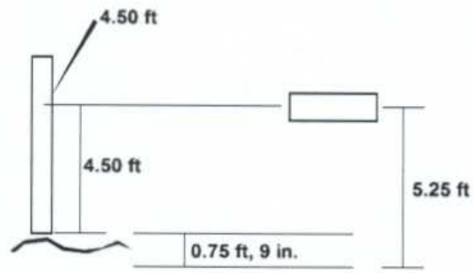


Figure 4

ARE YOU A STAND OUT IN YOUR FIELD?

6 - 8 SURVEYING **Lesson 3**

OVERVIEW

In the late 1990's the emergence of crop circles captured the world's imagination. See Figure 1. The big question was whether these works of art were created by men or aliens. In the end, it was discovered that men, not aliens, were responsible for the large and intricate displays.

Next came the question of how the crop circles were actually produced. It turns out that art, math, and engineering all came together in the production of the images in the crop fields. The magnificent shapes in the fields were inspired by, and became themselves, works of art. Math was used to compute the distances and angles which defined the edges of each shape. Surveying techniques were then used to transfer a design from paper to the ground in the field. All that remained was to apply some simple techniques for flattening a crop, and before anyone noticed a crop circle appeared overnight.

OBJECTIVES

The students will be able to:

1. measure distances, directions, and angles from a map
2. transfer distances, directions, and angles from a map to the ground

MATERIALS

- A geometric design
- Several fruit and vegetable cans
- Colored craft paper sheets in number equal to that of the number of cans
- Rubber bands in number equal to that of the number of cans
- 50 feet of string or a 25 to 50 foot measuring tape
- Protractor
- Ruler

ACTIVITY

The objective of this lesson is to transfer the dimensions of a design on paper to the ground. This is the same type of process used to position a structure in the correct location on a piece of land. In order to confirm that all dimensions are transferred correctly, try to find a location for laying out the design where you are able to view the design from above. For example, locate the design near a second or third story window in the school, near football or baseball bleachers, or near a playground structure such as a slide or platform.

1. This activity could be completed by the class as a whole, in pieces by individual groups, or as separate designs laid out by separate groups.
2. Give each group a geometric design or have the group create their own design.
3. Select a point on, or around, the design and designate this point as the origin of an x-y set of axes.
4. Establish a scale for the design, i.e. 1 inch on the paper = X feet on the ground.
5. Identify several other points along the edges of the design. Using geometry, determine the position of these points relative to the origin of the x-y axes. The students may choose to compute x and y coordinates or an angle and radial distance to locate a point.
6. Once the coordinates for each point have been determined, it is time to transfer these locations on to the ground. Place a piece of craft paper over the top of a fruit/vegetable can and secure it with a rubber band. The cans are to represent the points being transferred from the map to the ground.
7. Have the students establish the position of the x-y axes origin in the designated area. Use the string, or tape measure, to lay out distances. Place a can at each location where a point is to be transferred to the ground.
8. Once all points have been identified on the ground, move to the location where you can view your design from above. From this view, assess how well the students were able to transfer the position of a point on paper to a relatively similar position on the ground.

Figure 1

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

HOME
>>MORE

K Through 2nd Grade

Environmental

Just Say No To Trash
Let's Ask Mikey, He'll Drink Anything
Let Me Breath The Air

Geotechnical

Foundations: More Than A Cosmetic
The Great Wall Of Duplos
Where Has All The Soil Gone

Structures

What's In A Name
That Muffin Is Hard As A Rock
Humpty Dumpty Sat On A Wall

Surveying

Where's The Beef ?
My Guess Is As Good As Yours
My Foot Isn't Twelve Inches Long

Transportation

How To Get From Here To There
Signs, Signs, Everywhere A Sign
Through Thick And Thin

Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

HOME

<<BACK

K Through 2nd Grade

Index of Lesson Plans

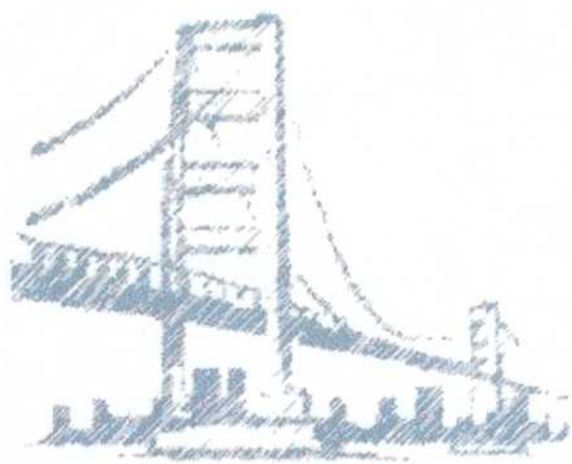
Bibliography

Related Books

Vocabulary List

Introductory Videoclip

Image Library



Civil Engineering - A Bridge to the Future

LESSON PLANS AND ACTIVITIES

Kindergarten – 2nd Grade

ENVIRONMENTAL

Lesson #1 – Just Say No To Trash

Lesson #2 – Let's Ask Mikey, He'll Drink Anything

Lesson #3 – Let Me Breath The Air

GEOTECHNICAL

Lesson #1 – Foundations: More Than A Cosmetic

Lesson #2 – The Great Wall of Duplos®

Lesson #3 – Where Has All The Soil Gone

STRUCTURES

Lesson #1 – What's In A Name

Lesson #2 – That Muffin Is Hard As A Rock

Lesson #3 – Humpty Dumpty Sat On A Wall

SURVEYING

Lesson #1 – Where's The Beef?

Lesson #2 – My Guess Is As Good As Yours

Lesson #3 – My Foot Isn't Twelve Inches Long

TRANSPORTATION

Lesson #1 – How To Get From Here To There

Lesson #2 – Signs, Signs, Everywhere A Sign

Lesson #3 – Through Thick And Thin

BIBLIOGRAPHY

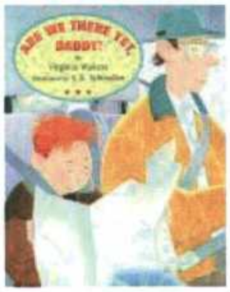
K-2nd Grade

Are We There Yet, Daddy?	Virginia Walters
Big Book of Things That Go	Caroline Bingham
Bridges Are to Cross	Philemon Sturges
Building the New Road (Tonka)	Justine Koman
Building the New School (Tonka)	Steven Petruccio
Cable Cars (Transportation Library)	Lola M. Schaefer
Cars	Anne E, Rockwell
Construction Trucks	Betsy Imershein
I Love Trains!	Philemon Sturges
I Love Trucks!	Philemon Sturges
I Read Signs	Tana Hoban
Keeping Water Clean	Helen Frost
Me on the Map	Joan Sweeney
Mighty Machines: Airplanes	Christopher Maynard
Mike Mulligan and His Steam Shovel	Virginia Lee Burton
My First Plane Ride	Elizabeth Benjamin
Oil Spill!	Melvin Berger
On the Go (Around the Worlds Series)	Ann Morris
Planes	Anne E, Rockwell
Pollution	Brian McIntyre
Pollution: Problems and Solutions	National Wildlife Federation
Red, Yellow, Green: What Do Signs Mean?	Joan Holub
Road Builders	B.G. Hennessy
Road Signs: A Hare-Y Race With a Tortoise	Margery Cuyler
Soil (Simply Science)	Alice K. Flanagan
Subway Rides (Let's Go)	Pamela Walker
Take Off!	Ryan Ann Hunter
The Amazing Dirt Book	Paulette Bourgeois

Things That Go	Anne E, Rockwell
Trains	Anne E, Rockwell
Two Little Trains	Margaret Wise Brown
Where Does Pollution Come From?	C. Vance Cast
Where Does the Garbage Go?	Paul Showers
Working Hard With the Mighty Crane (Tonka)	Justine Koman
Working Hard With the Mighty Loader (Tonka)	Justine Koman
Working Hard With the Mighty Mixer (Tonka)	Francine Hughes

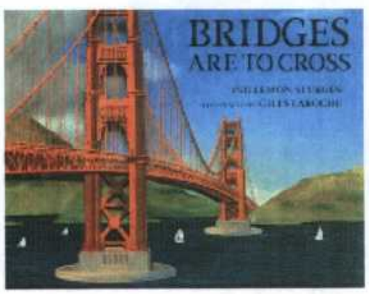
Book List

K-2nd Grade

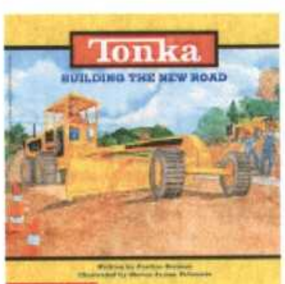


Are We There Yet, Daddy?
by Virginia Walters, S. D. Schindler (Illustrator), E. Law (Editor)
Reading level: Ages 4-8
School & Library Binding - 32 pages (September 1999)
Viking Childrens Books
ISBN: 0670874027

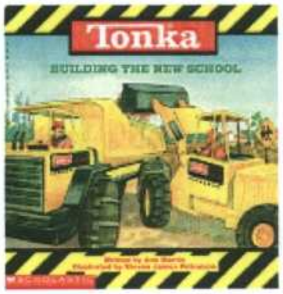
Big Book of Things That Go
by Caroline Bingham (Editor), Deni Bown
Reading level: Ages 4-8
Hardcover - 32 pages (September 1994)
DK Publishing
ISBN: 1564584623



Bridges Are to Cross
by Philemon Sturges, Giles Laroche (Illustrator), Philomen Sturges
Reading level: Ages 4-8
School & Library Binding - 32 pages (October 1998)
Putnam Pub Group Juv;
ISBN: 0399231749



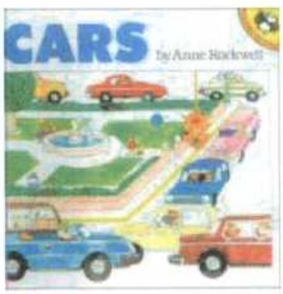
Building the New Road (Tonka, Storybooks)
by Justine Korman, Steven James Petruccio (Illustrator), Tonka Co. , Justine Korman-Fontes
Reading level: Ages 4-8
Paperback - 32 pages (May 1998)
Cartwheel Books
ISBN: 0590130935



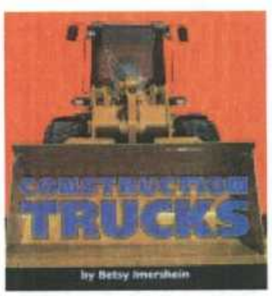
Building the New School (Tonka)
by Steven Petruccio (Illustrator), Tonka Corporation, Ann Matthews Martin
Reading level: Ages 4-8
Paperback (March 1995)
Scholastic Trade
ISBN: 0590203088

No Picture

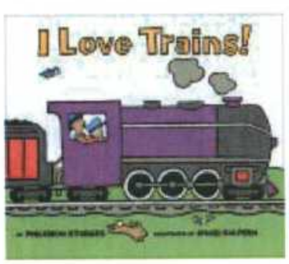
Cable Cars (Transportation Library)
by Lola M. Schaefer
Reading level: Ages 4-8
School & Library Binding - 24 pages (September 1999)
Bridgestone Books
ISBN: 0736803610



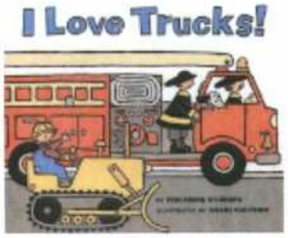
Cars
by Anne F. Rockwell
Reading level: Ages 4-8
Library Binding (October 1999)
Econo-Clad Books
ISBN: 0808572792



Construction Trucks
by Betsy Imershein (Illustrator)
Reading level: Ages 4-8
Hardcover - 14 pages Board edition (May 2000)
Little Simon
ISBN: 0689828888



I Love Trains!
by Philemon Sturges, Shari Halpern (Illustrator)
Reading level: Ages 4-8
Hardcover - 32 pages (April 24, 2001)
Harpercollins Juvenile Books
ISBN: 0060289007

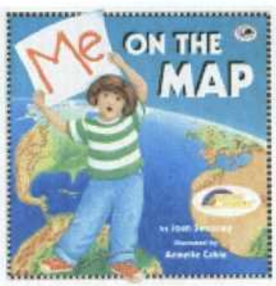


I Love Trucks!
by Philemon Sturges, Shari Halpern (Illustrator)
Reading level: Ages 4-8
Hardcover - 32 pages (February 1999)
Harpercollins Juvenile Books
ISBN: 0060278196

I Read Signs
by Tana Hoban
Reading level: Ages 4-8
Hardcover - 32 pages (October 1983)
William Morrow & Company
ISBN: 0688023177

No Picture

Keeping Water Clean (Frost, Helen, Water.)
by Helen Frost, Gail Saunders-Smith (Editor)
Reading level: Ages 4-8
School & Library Binding - 24 pages (September 1999)
Pebble Books
ISBN: 0736804080

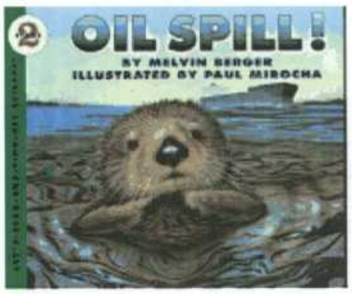


Me on the Map (Dragonfly Books)
by Joan Sweeney, Annette Cable (Illustrator)
Reading level: Ages 4-8
Paperback - 32 pages Reprint edition (July 1998)
Dragonfly
ISBN: 0517885573

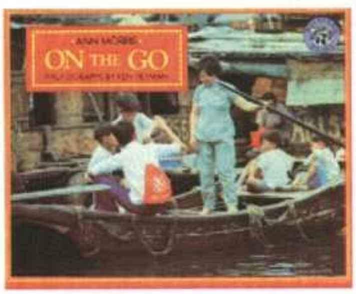
Mighty Machines: Airplanes
by Christopher Maynard, Deni Bown
Reading level: Ages 4-8
Hardcover - 24 pages (September 1995)
DK Publishing
ISBN: 0789402114

Mike Mulligan and His Steam Shovel
by Virginia Lee Burton
Format: Paperback, 44pp.
Publisher: Houghton Mifflin Company
Pub. Date: July 1977
Recommend Age Range: 5 to 8
ISBN: 0395259398

My First Plane Ride
by Elizabeth Benjamin, Mary Lonsdale (Illustrator)
Reading level: Ages 4-8
Hardcover - 16 pages (May 1999)
Unknown
ISBN: 0307333043



Oil Spill! (Let's Read-And-Find-Out Science, Stage 2)
by Melvin Berger, Paul Mirocha (Photographer), Paul Microcha (Illustrator)
Reading level: Ages 4-8
Paperback - 31 pages 1 Ed edition (April 1994)
HarperTrophy
ISBN: 0064451216

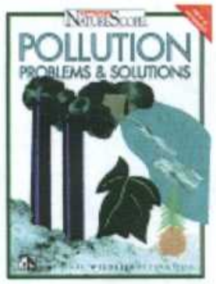


On the Go (Around the World Series)
by Ann Morris, Ken Heyman (Photographer), Amy Cohn (Editor)
Reading level: Preschool
Paperback - 28 pages (August 1994)
Mulberry Books
ISBN: 0688136370

Planes
by Anne F. Rockwell
Reading level: Ages 4-8
Paperback Reprint edition (April 1993)
Puffin
ISBN: 0140547827

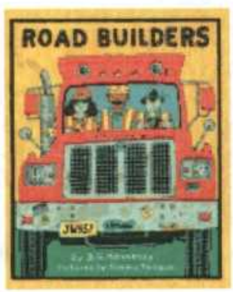
No Picture

Pollution (First Starts)
by Brian McIntyre (Illustrator), Janine Amos
Reading level: Ages 4-8
Paperback - 32 pages (April 1994)
Raintree/Steck-Vaughn
ISBN: 0811449173

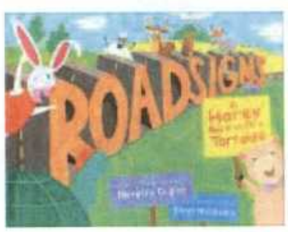


Pollution : Problems and Solutions (Ranger Rick's Naturescope)
by National Wildlife Federation
Reading level: Ages 4-8
Paperback - 96 pages Rev&Exp edition (July 1998)
McGraw-Hill;
ISBN: 0070471053

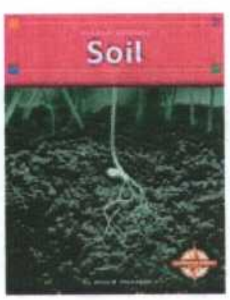
Red, Yellow, Green : What Do Signs Mean?
by Joan Holub
Reading level: Ages 4-8
Paperback - 16 pages (February 1998)
Cartwheel Books
ISBN: 0590134558



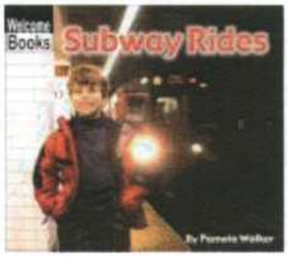
Road Builders
by B. G. Hennessy, Simms Taback (Illustrator)
Reading level: Ages 4-8
School & Library Binding - 32 pages (September 1994)
Viking Pr
ISBN: 0670833908



Road Signs : A Harey Race With a Tortoise
by Margery Cuyler, Steven Haskamp (Illustrator), Steve Haskamp (Illustrator)
Reading level: Ages 4-8
Hardcover - 40 pages 1 Ed edition (September 30, 2000)
Winslow Pr
ISBN: 1890817236



Soil (Simply Science)
by Alice K. Flanagan
Reading level: Ages 4-8
Library Binding - 32 pages (August 2000)
Compass Point Books
ISBN: 0756500354



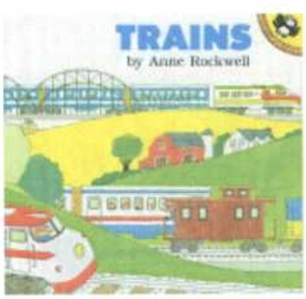
Subway Rides (Let's Go)
by Pamela Walker
Reading level: Ages 4-8
Paperback - 24 pages (September 2000)
Children's Press
ISBN: 051623028X

Take Off!
by Ryan Ann Hunter, Ed Miller (Illustrator)
Reading level: Ages 4-8
School & Library Binding - 32 pages (March 2000)
Holiday House
ISBN: 0823414663

No Picture

The Amazing Dirt Book
by Paulette Bourgeois, Craig Terlson (Illustrator), Valerie Wyatt (Contributor)
Reading level: Ages 4-8
Paperback (September 1990)
Perseus Pr
ISBN: 0201550962

Things That Go
by Anne F. Rockwell
Reading level: Preschool
Paperback Reprint edition (February 1991)
E P Dutton
ISBN: 0140547886



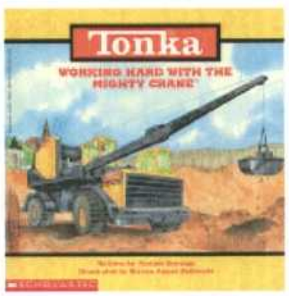
Trains
by Anne F. Rockwell
Reading level: Preschool
Paperback (March 1993)
Penguin USA (Juv); ISBN: 014054979X

Two Little Trains
by Margaret Wise Brown, Leo Dillon (Illustrator), Diane Dillon (Illustrator)
Reading level: Ages 4-8
Hardcover - 40 pages (April 24, 2001)
Harpercollins Juvenile Books
ISBN: 0060283769

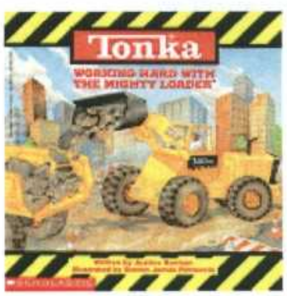
No Picture

Where Does Pollution Come From? (Clever Calvin Book)
by C. Vance Cast, Sue Wilkinson (Illustrator)
Reading level: Ages 4-8
Paperback - 40 pages (April 1994)
Barrons Juveniles
ISBN: 0812015711

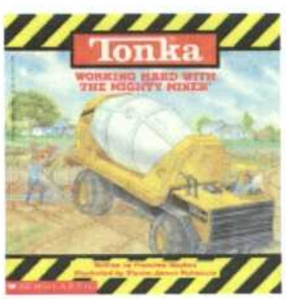
Where Does the Garbage Go? (Let'S-Read-And-Find-Out Science, Stage 2)
by Paul Showers, Randy Chewing (Illustrator), Paul Chewning (Illustrator), Randy Chewning (Illustrator)
Reading level: Ages 4-8
Paperback - 32 pages Revised edition (January 1994)
Harpercollins Juvenile Books
ISBN: 0064451143



Working Hard With the Mighty Crane (Tonka, Storybooks)
by Justine Korman, Steven James Petruccio (Illustrator), Tonka Co, Justine Korman-Fontes
Reading level: Ages 4-8
Paperback - 32 pages (May 1998)
Cartwheel Books
ISBN: 0590130943



Working Hard With the Mighty Loader (Tonka Trucks Storybook)
by Justine Korman, Steven James Petruccio (Illustrator), Tonka Corporation, Justine Korman-Fontes
Reading level: Ages 4-8
Paperback - 32 pages (November 1993)
Scholastic Trade
ISBN: 0590473026



Working Hard With the Mighty Mixer (Tonka)
by Francine Hughes, Steven James Petruccio (Illustrator), Justine Korman-Fontes
Reading level: Baby-Preschool
Paperback (November 1993)
Scholastic Trade
ISBN: 0590473085

Vocabulary List

K-2nd Grade

air
airplane
behind
block
bridge
build
building
bus
car
cement
circle
concrete
cure
dam
diamond
direction
dirt
East
erosion
far
feet
foundation
hard
horizontal
garbage
glue
front
land
map
measure
miles
mortar
nail
near
octagon
oil
on
pollution
rectangle
road
roadbed
sand
screw
sign
soft
soil
South
strength
strong
stable
stadium
train
transportation
travel
triangle
truck
under
vertical
wall
water
waste
West
wind
yards

Thumbnail Images
construction











Civil Engineering - A Bridge to the Future

Thumbnail Images

construction equipment

BACK










Civil Engineering - A Bridge to the Future

Thumbnail Images

construction materials

BACK

>>MORE












Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

Thumbnail Images

construction materials

<<BACK

Civil Engineering - A Bridge to the Future

Thumbnail Images

environmental

BACK

>>MORE











Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

BACK

Thumbnail Images

environmental

Civil Engineering - A Bridge to the Future

Thumbnail Images

geotechnical








Civil Engineering - A Bridge to the Future

Thumbnail Images

geotechnical

<<BACK
>>MORE











Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

Environmental

Structural

Geotechnical

Transportation

Surveying

by grade grouping

K to 2nd

3rd to 5th

6th to 8th

Production Credits

Thumbnail Images

geotechnical

<<BACK

>>MORE








Civil Engineering - A Bridge to the Future

Activities and Lesson Plans

by sub-discipline

- Environmental
- Structural
- Geotechnical
- Transportation
- Surveying

by grade grouping

- K to 2nd
- 3rd to 5th
- 6th to 8th

Production Credits

Thumbnail Images

geotechnical

<<BACK









Civil Engineering - A Bridge to the Future

Thumbnail Images

transportation











Civil Engineering - A Bridge to the Future