This presentation highlights the elements of an integrated engineering curriculum installed in an elementary school. The presentation will be of interest to those focused on the implementation of engineering education efforts that go beyond single lessons or grade level efforts.

An Integrated Experience for Elementary Engineering Education

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An Integrated Experience for Elementary Engineering Education

DOUGLAS L. JAMERSON, JR. ELEMENTARY
Center for Mathematics and Engineering

Population Profile

2008 Enrollment	Kindergarten	First	Second	Third	Fourth	Fifth
Steady State total 632	124	114	115	112	90	77
Classrooms	six	five	four	four	three	three

07-08 Demographics

location	white	Black	Hisp.	Asian/Am.	Multi-racial	Minority total
DL Jamerson	43%	40%	5%	2%	10%	57%
Area A	45%	37%	6%	5%	7%	55%
District	60%	20%	10%	4%	6%	40%

An Integrated Experience for Elementary Engineering Education

This presentation;

- highlights the elements of an integrated engineering curriculum installed in an elementary school.
- will be of interest to those focused on the implementation of engineering education efforts that go beyond single lessons or grade level efforts.

- Integrated Engineering Units of Study
- Jamerson Design Process
- Reading-Integration
- Grade level link(s)
- Learning Community Professional Development Activity

Integrated Engineering Units of Study

Why bother with this?

	grade	Reading		Mathematics		Writing	Science	
		% level 3 or up	% Lowest 25% make learning gains	% level 3 or up	% Lowest 25% make learning gains	% making the writing standard	% level 3 or up	% Title I
12-13	A							
11-12	A							
10 11	A	75	66	71	73	82	50	65
09-10	B	66	45	68	84	75	39	71
08-09	A	70	68	66	76	78	62	67
07-08	B	69	65	64	57	75	25	64
06-07	C	66	57	62	57	68	29	63

scores available from Florida Department of Education
(a level 3 score is the expected performance for a child in that topic.)

FLORIDA SCHOOL GRADES

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Florida Department of EDUCATION

DOE HOME · STUDENTS · EDUCATORS · COMMUNITY · FAMILIES · ADMINISTRATORS/STAFF

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An Integrated Experience for Elementary Engineering Education

- **Integrated Engineering Units of Study**
- Jamerson Design Process
- Reading-Integration
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Integrated Engineering Units of Study

Grade level

Engineering	Physical Science		Earth Science		Life Science	
Nature of Science and Engineering Interaction	Gravitational and Resultant Motion	Electromagnetic Force & Resultant Motion	Natural Resources	Space Exploration	Life Processes	Ecosystems

units

Science Concepts

Engineering Concepts

Mathematics Concepts

- Year separated into four sections
- Students work with homeroom teacher most of the day
- There is no “Engineering” period or class, engineering education is integrated into the teachers lesson plans for the whole day, everyday.

Integrated Engineering Units of Study

Kindergarten

	Engineering	Physical Science	
	Nature of Science and Engineering Interaction	Gravitational and Resultant Motion	Electromagnetic Force & Resultant Motion
units	Science, Inventors and Engineers	Humpty Dumpty; Goldilocks & 3 Bears; London Bridge; J&J	Jack be Nimble
Science Concepts	• • •	• • •	• • • • •
Engineering Concepts	• • •	•	•
Mathematics Concepts	•	•	•

Integrated Engineering Units of Study

Kindergarten

Engineering

Physical Science

	Nature of Science and Engineering Interaction	Gravitational and Resultant Motion	Electromagnetic Force & Resultant Motion
units	**Science, Inventors and Engineers**	**Humpty Dumpty; Goldilocks & 3 Bears; London Bridge; J&J**	**Jack be Nimble**
Science Concepts	• scientific processes, including observation & tools • teamwork • distinction between scientist, inventor, & engineer	• force as a push/pull • force as a vector (direction & magnitude) • safety • properties of materials	• workings of a candle • workings of a light bulb • distinction between scientist, inventor, & engineer
Engineering Concepts	• sources of energy • changes in lighting over time • Thomas Edison and his role	• work (force applied through a distance)	• Jamerson Design Process
Mathematics Concepts	• units as a component of scalars	• non-standard units for footprints	• qualitative measurement of light intensity

Integrated Engineering Units of Study

Kindergarten

	Physical Science		Earth Science	
	Gravitational Force	Electromagnetic Force & Resultant Motion	Natural Resources	Space Exploration
units	Jack be Nimble		Jack & Jill; 3 Billy Goats; London Bridge	3 Little Pigs/ Jack & Jill
Science Concepts	• workings of a candle • workings of a light bulb • distinction between scientist, inventor, & engineer		• what are natural resources • how are natural resources used • how natural resources can be conserved	• forces of weather affecting structures • properties of materials • states of matter • effects of the sun on various materials
Engineering Concepts	• Jamerson Design Process		• sources of water over time • George Washington Carver & crop rotation	• blueprints & footprints
Mathematics Concepts	• qualitative measurement of light intensity		• ordinal position • liquid (volume) measurements	• temperature measurement in degrees • count by 2s

Integrated Engineering Units of Study

Kindergarten

Earth Science — Life Science

Resources | Space Exploration | Life Processes | Ecosystems

	3 Little Pigs/ Jack & Jill	Animals as Engineers	Goldilocks &3 Bears
units			
Science Concepts	• forces of weather affecting structures • properties of materials • states of matter • effects of the sun on various materials	• life cycle • offspring • predators • body parts as tools • basic needs of living things • physical characteristics	• people's effects on other's environments • humans encroaching on animal's environment • animals interaction with their environment
Engineering Concepts	• blueprints & footprints	• natures engineers engineering ways to make life "easier" or "better"	• man's impact on animal's habitat • animal/ecosystem response to man's impact
Mathematics Concepts	• temperature measurement in degrees • count by 2s	• measurement in time	• counting scalar quantities • graphing

Integrated Engineering Units of Study

First Grade

Engineering

Physical Science

	Nature of Science and Engineering Interaction	Gravitational and Resultant Motion	Electromagnetic Force & Resultant Motion
units	Science, Inventors and Engineers	John Henry	Concept of Wave
Science Concepts	• scientific processes, including observation & tools • teamwork • distinction between scientist, inventor, & engineer	• force as vector • simple machines • gravity • scientific probeware	• What is a wave • What is light • What is sound • Concept of a simple circuit
Engineering Concepts	• Jamerson Design Process • Design constraints • Magic school bus	• concept of work & energy • Concept of machines making work “easier” • Henry Ford & assembly line	• Waves in force fields • Reproduction of a simple circuit using icons • demo of measuring voltage
Mathematics Concepts	• measurement • numbers vs scalars	• Distance measurements • Length in S.I. system	• Wave length measurement • Schematic diagram (circuit)

Integrated Engineering Units of Study

First Grade

	Physical Science		Earth Science	
	Gravitational Force	Electromagnetic Force & Resultant Motion	Natural Resources	Space Exploration
units		Concept of Wave	What are Natural Resources?	Weather & Flight
Science Concepts		• What is a wave • What is light • What is sound • Concept of a simple circuit	• Identification, states of matter • Concept of an atom • Properties of materials for insulation	• weather tools • water cycle • energy from the sun • effects of the sun • Window and its use
Engineering Concepts		• Waves in force fields • Reproduction of a simple circuit using icons • demo of measuring voltage	• Energy transfer between phases of matter	• Pressure/lift • Engineering of flight • Wright Brothers & early flight
Mathematics Concepts		• Wave length measurement • Schematic diagram (circuit)	• qualitative measure of internal energy	• Measurement in degrees • Count by 2s

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Integrated Engineering Units of Study

First Grade

Earth Science — Resources | Space Exploration

Life Science — Life Processes | Ecosystems

units	**Weather & Flight**	**Life Cycles**	**Plants in the Environment**
Science Concepts	• weather tools • water cycle • energy from the sun • effects of the sun • Window and its use	• life cycle focusing on plants, after a review of animals • basic needs of living things	• plants in the environment • role plants play in the ecosystem • adaptation of plants in the ecosystem
Engineering Concepts	• Pressure/lift • Engineering of flight • Wright Brothers & early flight	• energy cycle • food web	• energy conversion plants • optimization of growth parameters
Mathematics Concepts	• Measurement in degrees • Count by 2s	• measurement in time	• measure plant growth as function of light duration • graphing

Integrated Engineering Units of Study

Fourth Grade

Engineering

Physical Science

	Nature of Science and Engineering Interaction	Gravitational and Resultant Motion	Electromagnetic Force & Resultant Motion
units	**Science, Inventors and Engineers**	**Response of an Object in a Gravitational Force Field**	**Calculating Energy and Solar Energy**
Science Concepts	• comparison of scientists, inventors, & engineers • scientific method • scientific probeware	• Newton's Laws of Motion • Types of energy: potential, kinetic	• mass and force • simple and parallel circuits • role of electron as a source of charge • sources of energy
Engineering Concepts	• Jamerson Design Process • Elijah McCoy and his inventions	• quantitating resultant motion • calculation of work and power • drawing schematics • system losses	• gear ratio (MA) • calculation of work and power • design application of solar vehicles • reading & interpretation of real technical drawings
Mathematics Concepts	• Timelines of inventions	• multiplication • graphing • units	• multiplication • units

Integrated Engineering Units of Study

Fourth Grade

	Physical Science		Earth Science	
	Gravitational Force	Electromagnetic Force & Resultant Motion	Natural Resources	Space Exploration
units	Calculating Energy and Solar Energy		Early Tribes of Florida	Early Explorers Settling in Florida
Science Concepts	• mass and force • simple and parallel circuits • role of electron as a source of charge • sources of energy		• availability and usage of natural resources • early tools (simple machines)	• concept of world at the time • purpose of fort locations • construction of forts
Engineering Concepts	• gear ratio (MA) • calculation of work and power • design application of solar vehicles • reading & interpretation of real technical drawings		• calculating buoyant force • drawing free-body diagrams • use of natural resources to solve a problem	• design constraints of building forts • fort location optimization • material testing • schematics
Mathematics Concepts	• multiplication • units		• calculating volume • calculating mass and weight, force, density	• distance concepts • map scales • density

Integrated Engineering Units of Study

Fourth Grade

Earth Science — Resources | Space Exploration

Life Science — Life Processes | Ecosystems

	Early Explorers Settling in Florida	Florida's Plants	Man's impact on Florida Ecosystems
Science Concepts	• concept of world at the time • purpose of fort locations • construction of forts	• native plant structure • adaptations • photosynthesis • transpiration • absorption of minerals	• adaptations of plants and animals • focus on water quality • effects on plants / animals
Engineering Concepts	• design constraints of building forts • fort location optimization • material testing • schematics	• uses of plants for mankind • building materials from plants • "treating" materials for use • blueprints	• design water filtration systems • rate concepts • testing regimes • detection instruments
Mathematics Concepts	• distance concepts • map scales • density	• measurements • graphing	• measure "rate" • evaluating results • approximation

Fifth Grade

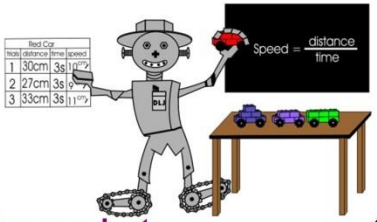
	People and Processes	Physical Science		Earth Science		Life Science	
	Nature of Science and Engineering Interaction	Gravitational Force and Resultant Motion	Electromagnetic Force & Resultant Motion	Natural Resources	Space Exploration	Life Processes	Ecosystems
Unit	**Scientists, Inventors, & Engineers**	**Bridges**	**Application of Magnetic and Electromagnetic Force Fields**	**Conservation of Natural Resources**	**Space Engineering**	**Development of Plants and Animals**	**Earth's Environment**
Science concepts	•scientific processes •influential people in science and engineering	•**identification of forces (tension, torsion, & compression) acting upon bridges** •mass and weight •concept of gravity	•identification of forces / fields •simple and parallel circuits used in creation of telegraph •electromagnets •scientific method	•man, erosion, & weathering's effects on natural resources •conservation	•comparison to to Mars; Earth's moon environ-ment • NASA's history & future •gravity / force in space (planets)	•human body systems functions •system interrelatedness •cell structure •heredity's effects	•animal adaptations •inherited vs. acquired traits •evolving of animals
Engineering concepts	•applying Jamerson Design Process •**different engineering fields** •technological improvements over time	•different types & uses of bridges •calculating of forces •strategies to create equilibrium •**live & dead loads** •distributed load •Roebling family & contributions •free-body diagrams	•measurement of forces •important people in these fields & their contributions •impact of technology on society •system losses	•roles of engineering •control for man's use; control to protect man •impact on society •**controlling beach erosion** •seawall design	•**impact of NASA engineering on society** •robotics for manipulating materials	•roles of engineering •**medical devices & prosthetics** •modern diagnostic instruments for system visualizations •mechanical advantage	•impact of engineering on environment •current negative impacts and solutions •humans ability to change environment •conservation, recycling and reusing
Math concepts	•measurement •estimation •problem solving	•measurement •graphing •**scalars & vectors** •**algebraic thinking**	•measurement •multiplication •**division**	•**rate concepts** •complex units (i.e., cm^3/gms, Newton•meters)	•place value •**powers of 10** •rounding •ratios	•ratios •calculating mechanical advantage	•measurement •**percentages**

An Integrated Experience for Elementary Engineering Education

- Integrated Engineering Units of Study
- **Jamerson Design Process**
- Reading-Integration
- Grade level link(s)
- Learning Community Professional Development Activity

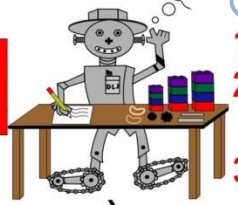
Jamerson Engineering Design Process

How can I use these materials to design a fast car with a limited energy supply?



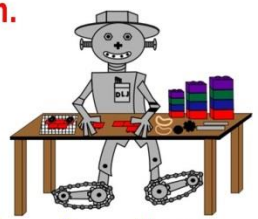
1. Communicate achievements.

Plan



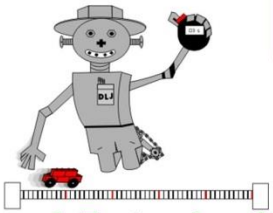
1. Identify the design problem.
2. Clarify the design limitation and requirements.
3. Investigate (research) the problem.

Design



1. Generate design alternatives.
2. Choose the best option and explain why.
3. Develop a design model or prototype.

Check



1. Test and evaluate the design solution.
2. Modify the design to meet developing needs.

Share

Examples of Designed Based Activities			
House design & construction	Household utensil invention	Magnetic powered transportation	Erosion prevention & weathering
Insulated lunchboxes	Monument design	Fort wall design	Model ecosystem
Solar cars & cookers	Schematic drawings	Energy source designs	Tower designs
Simple machines	Space podcast	Water filtration	Telegraph

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An Integrated Experience for Elementary Engineering Education

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Reading Integration

grade	Science Unit of study	Literature Titles	Reading Focus Strategy/Skill	Engineering Connection
K	Gravitational Force / Resultant Motion	Humpty Dumpty	Phonemic awareness, making predictions, sequencing, drawing conclusions	Build and test appropriate devices to prevent Humpty Dumpty from falling off the wall and ways to protect him from breaking if he fell off the wall
1	Gravitational Force / Resultant Motion	John Henry	Cause and effect, main and supporting details, comparison of different versions of John Henry	Build boats for John Henry and test them; sink and float, test for push and pull with “wind” power.
2	Life Systems	It Could Still be a Mammal	Classifying	Describe, classify, and sort the various characteristics of mammals using pictures.
3	Space Exploration	Magic School Bus Lost in Solar System	Separate fact and fiction, drawing conclusions, summarize	Design a space suit in order to survive on a student selected planet.
4	Natural Resources	The Calusas	nonfiction text elements to deepen text comprehension , draw conclusions /summarize.	Build, test clay dugouts; Mass measurements, weight calculations; and buoyant force determination.
5	Electromagnetic Force / Resultant Motion	Edison	Main ideas, supporting details, predicting and drawing conclusions	Build and test circuits, telegraph,, identify changes due to advances in communication.

An Integrated Experience for Elementary Engineering Education

- Integrated Engineering Units of Study
- Jamerson Design Process
- Reading-Integration
- **Grade level link(s)**
- Learning Community Professional Development Activity

Measurements:
Simple to complex and every year

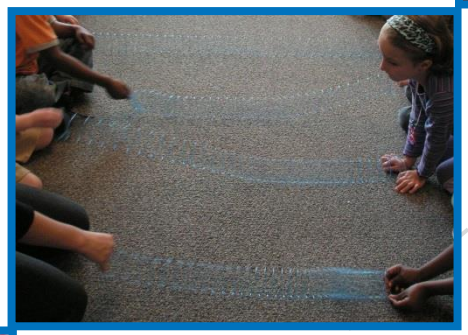
Grade level link(s)

Fifth grade

Third grade

Fourth grade

Second grade



First grade

Kindergarten

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Grade level link(s)

grade	Gravitational Force and Resultant Motion Strand	
K	Introduce forces as push or pulls through fairy tales: Goldilocks, Humpty Dumpty, The 3 Bears.	• Build chair to support mass of 2 different Goldilocks dolls • Finds ways to keep Humpty from falling / design Personal Protective Equipment
1st	Introduce work through the folk tale of John Henry	• Build puff “steam engines” • Build boats that float and move by wind power. • Build lunch box with healthy foods that for J.H.
2nd	Introduce potential and kinetic energy as well as friction.	• Build a marble drop which meets specific design criteria.
3rd	Introduce mechanical advantage of work through simple machines as well as finding mass in grams and weight in Newton.	• Design a pulley system with specific mechanical advantage requirements.

An Integrated Experience for Elementary Engineering Education

Grade level link(s)

grade — Gravitational Force and Resultant Motion Strand

4th Introduce calculations of volume, density, buoyant force, power, live and dead loads, as well as the construction of free body diagrams and technical drawings.

- Build and test clay dugouts
- Calculate buoyant force and create free body diagram
- Sketch technical diagram for a K'Nex car.
- Build car, test, measure and calculate performance parameters.

5th Introduce various types of bridge designs, various forces acting on a bridge (tension, torsion, compression). Calculate their strength, distributive load, state of failure.

- Calculate forces and show applied forces through free body diagram
- Design, build model bridge scaled to a design criteria load. (fails when expected to do so)
- Complete a cost analysis of their bridge design.

An Integrated Experience for Elementary Engineering Education

- Integrated Engineering Units of Study
- Jamerson Design Process
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- Grade level link(s)
- **Learning Community Professional Development Activity**

An Integrated Experience for Elementary Engineering Education

Science

- Quartz has an interesting property when it is compressed.

Quartz Crystal

Air Bag Technology

STEM

Learning Community Professional Development Activity

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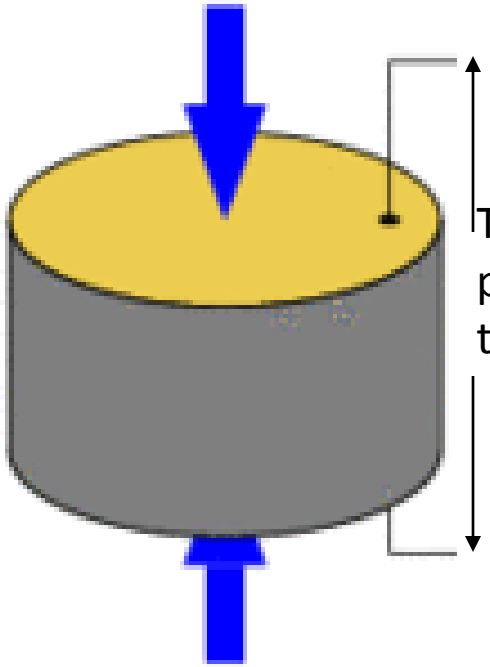
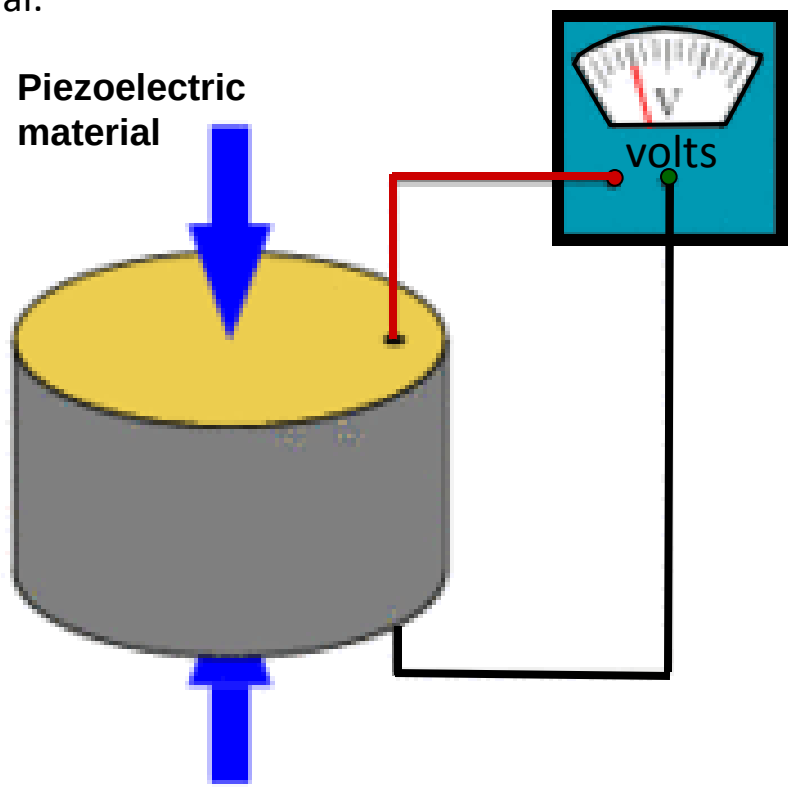
Science

- Quartz has an interesting property when it is compressed.
- Force is a pull or push.
- Work is done if the force moves something.



These two crystal planes are parallel to the applied force

A volt meter measures the difference between the energy level at the red terminal and the energy level at the green terminal.

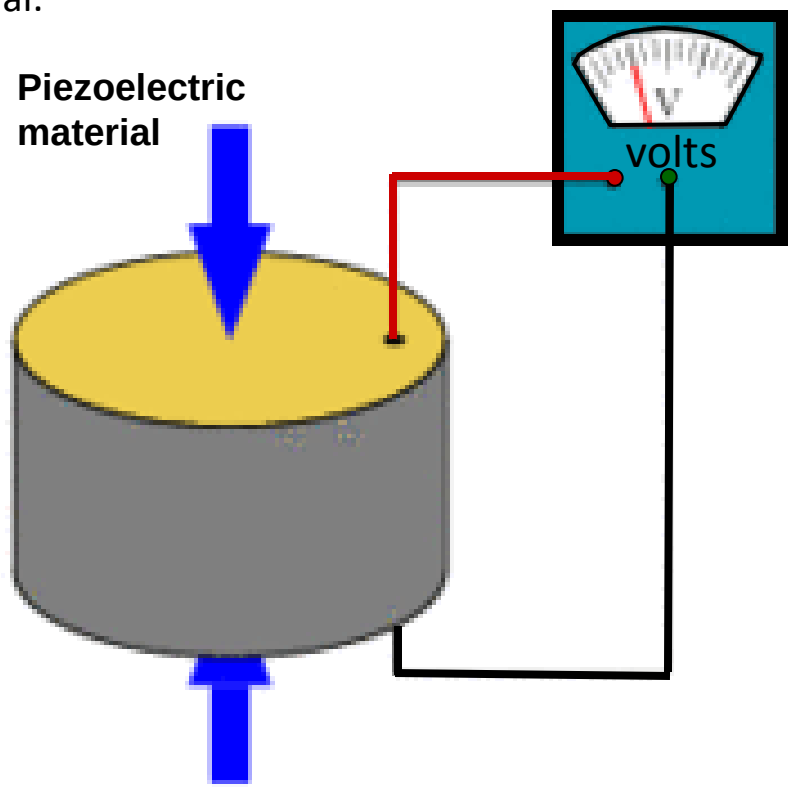


Engineering

- The voltage (energy) difference between the red wire and the black wire goes up and down.
- The voltage (energy) difference between the red wire and the black wire goes up when the crystal is compressed.
- The voltage (energy) difference between the red wire and the black wire goes down as the crystal returns to its original shape.
- Early application- vibrator in a handheld microphone.

- Where does the force come from to make the microphone piezoelectric material vibrate?

A volt meter measures the difference between the energy level at the red terminal and the energy level at the green terminal.



Mathematics

- The voltage (energy) difference equals the voltage value on the red wire minus the voltage value on the black wire.
- The work done is the value for the force multiplied by the distance the crystal compresses.
- For this sensor, if the force applied equals 200 Newton and the distance compressed equals 0.01 meters, how much work was done to compress the sensor?

200 Newton multiplied by 0.01 meters equals 2 Newton-meter.

Note: 1 Newton-meter is also called 1 Joule

- The stars of today's reaction

Sodium atom

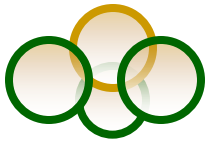
Nitrogen atom

Oxygen atoms

Potassium atom

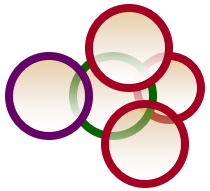
- The roles they play in today's reaction

Sodium Azide



NaN_3

Potassium Nitrate



KNO_3

-

Science

- The airbag's inflation system uses a hot blast of the nitrogen to inflate the airbag.

An Integrated Experience for Elementary Engineering Education

- The stars of today's reaction

Sodium atom

Nitrogen atom

Oxygen atoms

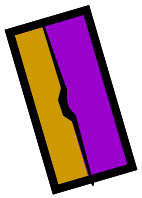
Potassium atom

Science

- The airbag's inflation system uses a hot blast of the nitrogen to inflate the airbag.

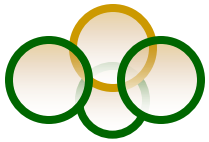
Engineering

- The reactants can be packaged as two solids in a container.



- The roles they play in today's reaction

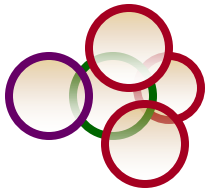
Sodium Azide



NaN_3

(solid state)

Potassium Nitrate

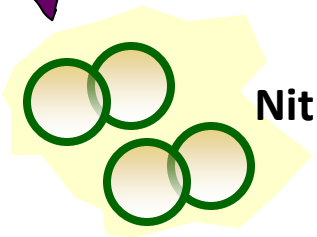


KNO_3

(solid state)

- The reaction

heat



Nitrogen in the gas state

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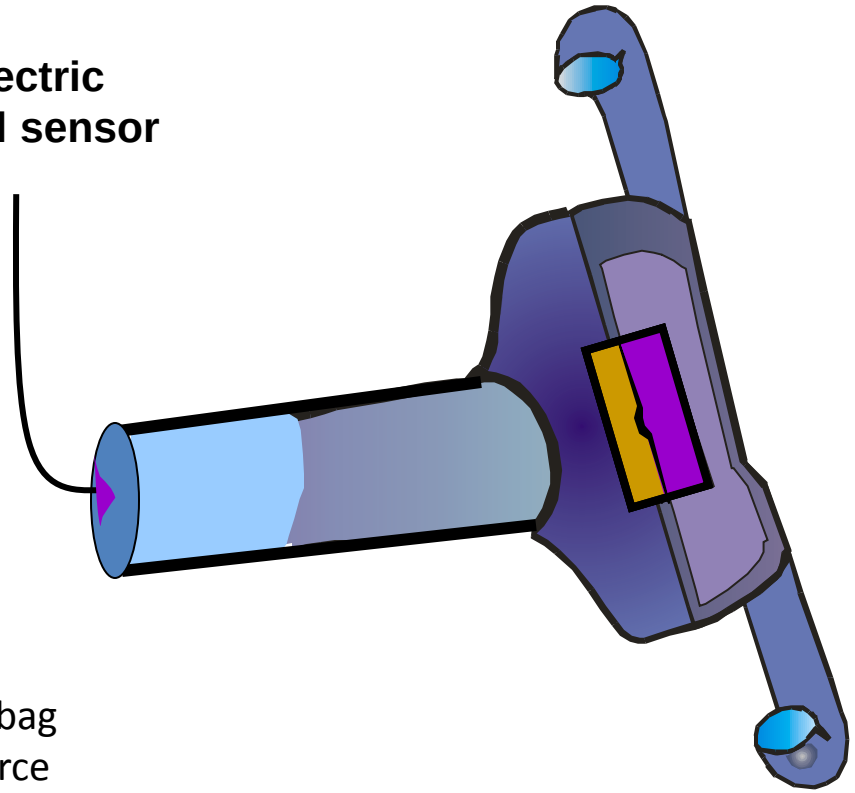
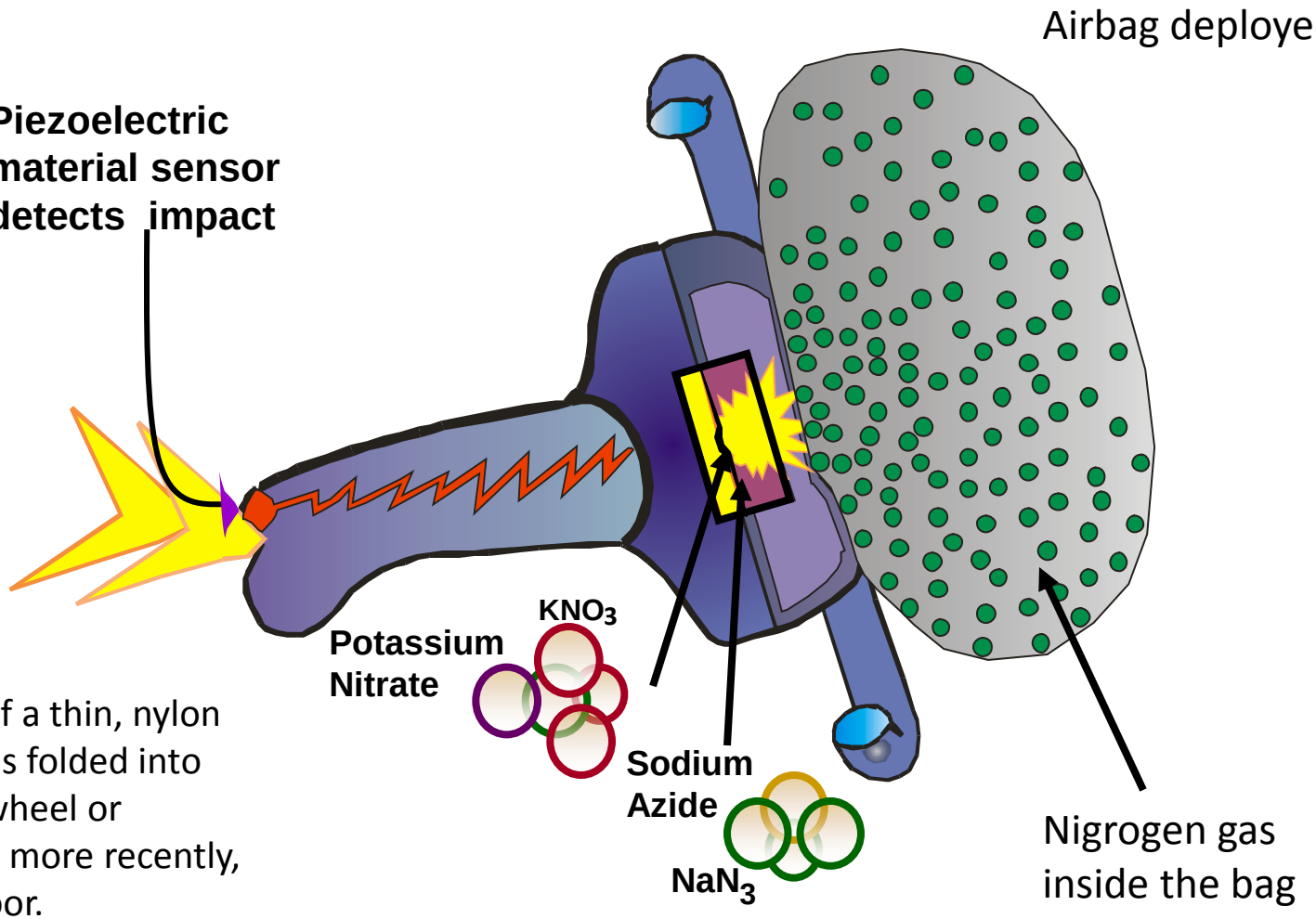


Engineering

- Sensor triggers when bag should inflate. (The force from a 15 mile per hour collision with a brick wall)

Cutaway cartoon view of a car steering wheel.



Engineering

- bag is made of a thin, nylon fabric, which is folded into the steering wheel or dashboard or, more recently, the seat or door.

Cutaway cartoon view of a car steering wheel.

An Integrated Experience for Elementary Engineering Education

Air Bag Technology-STEM

- The stars of today's reaction

Sodium atom

Nitrogen atom

Oxygen atoms

Potassium atom

- The roles they play in today's reaction

Sodium Azide

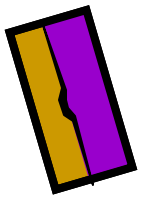
NaN_3

(solid state)

Potassium Nitrate

KNO_3

(solid state)



- The reaction

heat

Nitrogen in the gas state

Science

- The airbag's inflation system uses a hot blast of the nitrogen to inflate the airbag.

Engineering

- The reactants can be packaged as two solids in a container.

Mathematics

- The volume of the gas at atmospheric pressure can be calculated.
- The time it takes to blow up a bag of the nitrogen gas can be measured.

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For more information about the Math and Engineering program at Douglas L. Jamerson, Jr. Elementary School in St. Petersburg, FL,

- Integrated Engineering Units of Study
- Jamerson Design Process
- Reading-Integration
- Grade level link(s)
- Learning Community Professional Development Activity

Thanks for your interest in Elementary Engineering Education!!

website at www.jamerson-es.pinellas.k12.fl.us,

An Integrated Experience for Elementary Engineering Education

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For more information about the Math and Engineering program at Douglas L. Jamerson, Jr. Elementary School in St. Petersburg, FL,

- Integrated Engineering Units of Study
- Jamerson Design Process
- Reading-Integration
- Grade level link(s)
- Learning Community Professional Development Activity

Thoughts, comments, questions?

website at www.jamerson-es.pinellas.k12.fl.us,

An Integrated Experience for Elementary Engineering Education

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Detail, details, maybe we do need the details.

	Title	Annual ASEE Conference & Exposition
(a)	Engineering an Elementary School Environment to Enhance Learning.	2008-1487
(b)	Integration of Elementary Engineering Elements into the Language Arts Programs	2007-1901
(c)	Supporting Math and Science through Elementary Engineering in Elementary Education.	2007-1857
(d)	Engineering is Elementary: An Engineering and Technology Curriculum for Children.	2007-8
(e)	Essential Element Examples of Elementary Engineering in Elementary Education.	2006-1158

1) **Google ASEE & papers**
2) **Use ASEE Search Engine with either name;**

   Richard Gilbert

   Marilyn Barger

An Integrated Experience for Elementary Engineering Education

Supplementary Information

Kindergarten

	People and Processes	Physical Science		Earth Science		Life Science	
	Nature of Science and Engineering Interaction	**Gravitational Force and Resultant Motion**	**Electromagnetic Force & Resultant Motion**	**Natural Resources**	**Space Exploration**	**Life Processes**	**Ecosystems**
Unit	**Scientists, Inventors, and Engineers**	**Humpty Dumpty** Goldilocks & 3 Bears 3 Billy Goats & London Bridge Jack & Jill 3 Little Pigs	**Jack Be Nimble**	**Jack & Jill** **3 Billy Goats & London Bridge** **3 Little Pigs**	**3 Little Pigs** **Animals as Engineers** **3 Billy Goats** **Jack & Jill**	**Animals as Engineers**	**Goldilocks & 3 Bears** **Animals as Engineers**
Science concepts	•scientific processes, including observation & tools •teamwork •distinction between scientist, inventor, & engineer	•force as a push and pull •gravity •safety •properties of materials	•workings of a candle •workings of a light bulb •distinction between scientist, inventor, & engineer	•what are natural resources •how are natural resources used •how natural resources can be conserved	•forces of weather affecting structures •properties of materials •states of matter •effects of the sun on various materials	•life cycle •offspring •predators •body parts as tools •basic needs of living things •physical characteristics	•people's effects on other's environments •humans encroaching on animal's environment •animals interaction with their environment
Engineering concepts	•Jamerson Design Process	•blueprints & footprints	•sources of energy •changes in lighting over time •Thomas Edison and his role	•sources of water over time •George Washington Carver & crop rotation	•blueprints & footprints	•nature's engineers •engineering as a way to make life "easier" or "better"	•man's impact on animal's habitat •animal / ecosystem response to man's impact
Math concepts	numbers and scalars	•measurements	•qualitative measurement of light intensity	•ordinal position •liquid (volume) measurements	•temperature measurement in degrees •count by 2s	•measurement in time	•counting scalar quantities •graphing concepts

First Grade

	People and Processes	Physical Science		Earth Science		Life Science	
	Nature of Science and Engineering Interaction	**Gravitational Force and Resultant Motion**	**Electromagnetic Force & Resultant Motion**	**Natural Resources**	**Space Exploration**	**Life Processes**	**Ecosystems**
Unit	**Scientists, Inventors, and Engineers**	**John Henry**	**Concept of Waves**	**What are Natural Resources?**	**Weather & Flight**	**Life Cycles**	**Plants in the Environment**
Science concepts	•scientific processes, including observation & tools •teamwork •distinction between scientist, inventor, & engineer	•force as a push and pull •simple machines •gravity •scientific probeware	•what is a wave •what is light •what is sound •concept of a simple circuit	•identification, states of matter •concept of an atom •properties of materials for insulation	•weather tools •water cycle •energy from the sun •effects of the sun •wind and its use	•life cycles, focusing on plants after a review of animals •basic needs of living things •food chain	•plants in the environment •adaptation of plants in the environment •comparison of plant growth & light duration
Engineering concepts	•Jamerson Design Process •design constraints	•concept of work/energy •concept of machines making work easier •Henry Ford & assembly line	•waves in force fields •reproduction of a simple circuit using icons •demo of measuring voltage	•energy transfer between phases of matter	•pressure /lift •engineering of flight •Wright Brothers & early flight	•energy cycle •creating optimal conditions for plant growth	•energy conversion of plants •changing environmental conditions to optimize plant growth
Math concepts	•measurement •numbers vs. scalars	•distance measurements •length in S.I. system (cm) •elapsed time	•wave length measurement •schematic diagram (circuit)	•qualitative measure of internal energy •elapsed time	•measurement in degrees •count by 2s	•elapsed time •height in S.I. system (cm)	•measurement plant growth •elapsed time •graphing

Second Grade

	People and Processes	Physical Science		Earth Science		Life Science	
	Nature of Science and Engineering Interaction	**Gravitational Force and Resultant Motion**	**Electromagnetic Force & Resultant Motion**	**Natural Resources**	**Space Exploration**	**Life Processes**	**Ecosystems**
Unit	**Scientists, Inventors, Engineers**	**Applied Forces**	**Waves in Force Fields**	**Rock, Minerals, & Metals**	**Sun, Earth, & Moon Relationship**	**Classification of Animals**	**Animal Habitats**
Science concepts	•scientific processes •use of tools for collecting data •safety •teamwork •scientist, inventor, & engineer	•gravity •friction •mass and weight •energy •momentum •inclined plane •scientific probeware	•magnetic force field •comparison of magnetic force field with other force fields •current flow •electromagnet	•formation •various properties •how to test	•rotation and tilt of the Earth •moon phases •seasons •NASA lunar history & future •scientific tools	•various ways animals can be classified •body systems of animals •food chain	•various animal habitats, including plants •how habitats supply basic needs of living things •growth & development of animals
Engineering concepts	•Jamerson Design Process •applying design constraints •schematic representations	Concept of •total energy •potential energy •work •heat •kinetic energy •energy conservation	•open & closed systems •simple circuit icon drawings, adding details •series circuits •maglev train •William Gilbert's contributions	•applying knowledge to monument structures •blueprints •elevations & footprints •scaled drawings	•engineering in space •maintaining basic needs in space	•population density in habitat •conservation laws	•design requirements of animal shelters •comparison to human shelters •controlled environments
Math concepts	•measurement •patterning •numbers vs. scalars •graphing	Work related: •force measurements •distance measurements	•engineering scalar measurements (energy in volts)	•measurements •relative magnitude •area •perimeter	•measurement in degrees •count by 2s	•measurement in time •population density concepts	•measurements

Third Grade

	People and Processes	Physical Science		Earth Science		Life Science	
	Nature of Science and Engineering Interaction	**Gravitational Force and Resultant Motion**	**Electromagnetic Force & Resultant Motion**	**Natural Resources**	**Space Exploration**	**Life Processes**	**Ecosystems**
Unit	**Scientific Method and Jamerson Design Process**	**Simple Machines**	**Transferring Energy from Wave Sources**	**Landforms, Erosion, and Weathering**	**Planets in Solar System, Stars, & Moon**	**Flow of Energy Through a Life System**	**Animal Biomes**
Science concepts	•scientific processes •scientific method •classifying	•identification •real world usage •locating simple machines in compound machines •mass and weight	•forms of energy •chemical and physical reactions •properties of materials •heat gain/loss •energy source/ sink	•various kinds of landforms •difference between erosion and weathering	•identification of planets •similarities & differences in planets •human needs	•predator and prey •food chain •plant systems	•interconnected-ness of plants and animals within a biome •food web •competition •types of biomes
Engineering concepts	•Jamerson Design Process	•mechanical advantage (MA) •calculating MA in pulley system •Archimedes' contributions •Real world connections	•circuit diagrams •energy conservation in circuits •neatness in detail •thermal insulator •parallel circuits	•role of engineering •controlling the environment for man •using the environment •engineering erosion barrier	•gravitational force field comparison •design space shelter	•role of engineering •optimizing food resources •harnessing the sun as an energy source	•man's impact on biome •conservation principles in biomes •engineering animal habitat
Math concepts	•scalar measurement units associated with scientists and engineers	•measurement in grams, Newtons, cm •addition •numbers, scalars, and vectors	•voltage drop measurements •numbers, scalars, and vectors	•elapsed time •scale	•gravity comparisons •place value •scale & proportion •scalars & vectors	•area •measurement •elapsed time	•simple balances •area •perimeter •scale & proportion •graphing

Fourth Grade

	People and Processes	Physical Science		Earth Science		Life Science	
	Nature of Science and Engineering Interaction	Gravitational Force and Resultant Motion	Electromagnetic Force & Resultant Motion	Natural Resources	Space Exploration	Life Processes	Ecosystems
Unit	**Scientists, Inventors, and Engineers**	**Response of an Object in a Gravitational Force Field**	**Calculating Energy and Solar Energy**	**Early Tribes of Florida**	**Early Explorers Settling in Florida**	**Florida's Plants and Animals**	**Man's Impact on Florida Ecosystems**
Science concepts	•comparison of scientists, inventors, & engineers •scientific method •scientific probeware	•Newton's Laws of Motion •potential and kinetic energy •variables: constant, manipulating, and responding •mass and weight	•sources of energy •changes of matter •transfer of heat •radiation, conduction, convection	•availability and usage of natural resources •density of liquids •buoyancy •availability of water sources	•fort locations meeting basic needs •natural resources used in fort construction •wind as a force	•native plant structure •photosynthesis •transpiration •absorption of minerals •life cycles •classification of animals	•water quality •effects on plants/animals •energy flow •parts of systems
Engineering concepts	•Jamerson Design Process •Elijah McCoy and his inventions •timelines of inventions	•quantitizing resultant motion •calculation of work and power •drawing schematics •system losses	•design application of solar cookers •understanding material efficiency	•calculating buoyant force •drawing free-body diagrams •problem solving using natural resources •early tools	•fort design constraints •fort location optimization •material testing •schematics •navigational tools	•uses of plants for mankind •building materials from plants •"treating" materials for use	•design water filtration systems •rate concepts •testing regimes •detection instruments •open/closed systems
Math concepts	•elapsed time •scale •place value •graphing	•scalars & vectors •multiplication •graphing •decimals •volume •Measurement units	•multiplication •measurements •decimals •temperature	•decimals •multiplication Calculation of: •volume •Mass, weight/ Force and density	•distance concepts •map scales •measurement •scalars & vectors	•measurement •graphing •elapsed time	•measure "rate" (complex unit) •analyzing results •approximation •measurement

Fifth Grade

	People and Processes	Physical Science		Earth Science		Life Science	
	Nature of Science and Engineering Interaction	Gravitational Force and Resultant Motion	Electromagnetic Force & Resultant Motion	Natural Resources	Space Exploration	Life Processes	Ecosystems
Unit	**Scientists, Inventors, & Engineers**	**Bridges**	**Application of Magnetic and Electromagnetic Force Fields**	**Conservation of Natural Resources**	**Space Engineering**	**Development of Plants and Animals**	**Earth's Environment**
Science concepts	•scientific processes •influential people in science and engineering	•identification of forces (tension, torsion, & compression) acting upon bridges •mass and weight •concept of gravity	•identification of forces / fields •simple and parallel circuits used in creation of telegraph •electromagnets •scientific method	•man, erosion, & weathering's effects on natural resources •conservation	•comparison to to Mars; Earth's moon environ-ment • NASA's history & future •gravity / force in space	•human body systems functions •system interrelatedness •cell structure •heredity's effects	•animal adaptations •inherited vs. acquired traits •evolving of animals
Engineering concepts	•applying Jamerson Design Process •different engineering fields •technological improvements over time	•different types & uses of bridges •calculating of forces •strategies to create equilibrium •live & dead loads •distributed load •Roebling family & contributions •free-body diagrams	•measurement of forces •important people in these fields & their contributions •impact of technology on society •system losses	•roles of engineering •control for man's use; control to protect man •impact on society •controlling beach erosion •seawall design	•impact of NASA engineering on society •robotics for manipulating materials	•roles of engineering •medical devices & prosthetics •modern diagnostic instruments for system visualizations •mechanical advantage	•impact of engineering on environment •current negative impacts and solutions •humans ability to change environment •conservation, recycling and reusing
Math concepts	•measurement •estimation •problem solving	•measurement •graphing •scalars & vectors •algebraic thinking	•measurement •multiplication •division	•rate concepts •complex units (i.e., cm^3/gms, Newton•meters)	•place value •powers of 10 •rounding •ratios	•ratios •calculating mechanical advantage	•measurement •percentages

Airbag Information

Supplementary Information

The challenge:

Early efforts to adapt the airbag for use in cars were restricted by prohibitive prices and technical hurdles involving the storage and release of compressed gas. Engineers wondered:

If there was enough room in a car for a gas canister ?

Whether the gas would remain contained at high pressure for the life of the car?

How the bag could be made to expand quickly and reliably at a variety of operating temperatures and without emitting an ear-splitting bang?

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Airbag Information

The design

Material:
The bag itself is made of a thin, nylon fabric, which is folded into the steering wheel or dashboard or, more recently, the seat or door.

The airbag's inflation system :
The system uses the reaction of sodium azide (NaN3) with potassium nitrate (KNO3) to produce nitrogen gas. Hot blasts of the nitrogen inflate the airbag. Similar to rocket technology but at a much, much smaller scale, the inflation system uses a solid propellant and an igniter. Small solid-propellant inflators (see How Rocket Engines Work for details) were manufactured that burn extremely rapidly to create a large volumn of gas to inlfate the bag..

The airbag's inflation system :
Upon impact and the generation of a spark do to the voltage created when the crash impact compressed the quartz's the bag then literally bursts from its storage site at up to 200 mph (322 kph). The gas quickly dissipates through tiny holes in the bag, thus deflating the bag so you can move. Even though the whole process happens in only one-twenty-fifth of a second, the additional time is enough to help prevent serious injury. The powdery substance released from the airbag cornstarch or talcum powder, which is used by the airbag manufacturers to keep the bags pliable and lubricated while they're in storage.