Expanded Summary of Curriculum Units

Engineering Program of Study
Integrated Curriculum Units

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ConnectEd
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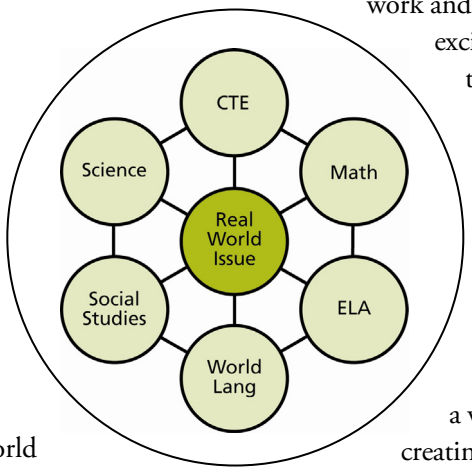
What is Multidisciplinary Integrated Curriculum?

The term "integrated curriculum" has many different, sometimes conflicting, meanings to different educators. In the context of the multiple pathways approach, we use integrated curriculum to refer to an instructional method and materials for *multidisciplinary* teams of teachers to organize their instruction so that students are encouraged to make meaningful connections across subject areas. English, mathematics, science, social studies, and career technical teachers all collaborate to plan and present lessons that center around a central, career–themed issue or problem. The outlines included in this summary provide examples of multidisciplinary integrated curriculum designed by ConnectEd for use in the Engineering and Design pathway.

Characteristics of An Effective Multidisciplinary Integrated Curriculum[1]

- **Academic and Technical Rigor**—Curriculum units are designed to address key learning standards identified by the district.
- **Authenticity**—Units use a real-world context (e.g., community and workplace problems) and address issues that matter to the students.
- **Applied Learning**—Units engage students in solving problems that call for competencies expected in high-performance work organizations (e.g., teamwork, problem-solving, communication, etc.).
- **Active Exploration**—Units extend beyond the classroom by connecting to internships, field-based investigations, and community explorations.
- **Adult Connections**—Units connect students with adult mentors and coaches from the community's industry and postsecondary partners.
- **Assessment Practices**—Units involve students in regular performance-based exhibitions and assessments of their work; evaluation criteria reflect personal, school, and real-world standards of performance.



Goals of a Multidisciplinary Integrated Curriculum

- **Increase Active Learning**—Integrated curriculum shifts classroom instruction from passive to active, thereby engaging more students in the learning process. Students become the center of the learning experience by collaborating in real-life career-focused projects and problems that connect to their current interests and future pursuits.
- **Develop Students' Educational and Career Planning Skills**—By participating in professional work and engaging with employees who address exciting and challenging problems in their jobs, students recognize the need to perform well in high school, understand the educational pathways leading to a variety of rewarding careers, and pursue postsecondary education or training to achieve personal career goals. Integrated curriculum also provides students with knowledge of a wide variety of career-related fields by creating research opportunities and career connections with professionals in many jobs within a career area.
- **Reach a Diverse Population**—Students who participate in integrated curricula are able to express their own interests, demonstrate their unique skills, and master high-level academic and technical material by applying a variety of learning styles.
- **Build Community Support for Improving High Schools**—By engaging key industry, education, and community-based stakeholders in their local areas, these educators are creating support for schools and proactive education improvement policies, and providing future employment opportunities for their students.

[1] Based on A. Steinberg (1997). *Real Learning, Real Work*. New York: Routledge.

Ship Shape

Integrated Curriculum Unit for Introduction to Engineering Design

This integrated unit focuses on the theme of naval architecture. Students are introduced to naval engineering and the history of sailing and ship design, both romantic and pragmatic. Students explore the science and math associated with designing seaworthy vessels, and the unit culminates in a design challenge where students prepare and present a contract bid for a series of ships, including drawings, technical documents, and a prototype.

Subunit 1 Overview	High Seas Adventure	Curriculum Materials
Lesson 1.1 Introduction to Engineering Design	Lure of the Sea *Students are introduced to the integrated unit and the general field of naval engineering and architecture. Students are asked to describe an experience they associate with freedom/escape, and then read the opening paragraph of Moby Dick describing the yearning for travel on the open water. A short history of naval architecture with an emphasis on differences in boat design is provided.*	• Lesson plan • Handout: Ship Taxonomy • PowerPoint: Ship Shape • Handout: Shipyard Scavenger Hunt
Lesson 1.2 English Language Arts	Sailing the Wine Dark Sea *Students read and discuss a variety of sailing stories using literature circles. Possible authors include Patrick O'Brian, Richard Hakluyt, C. S. Forester, Herman Melville, Richard Dana, Thor Heyerdahl, Homer, and Greek mythology.*	• Lesson plan • Reading: Moby Dick • Handout: Literature Circles • Handout: Book Selection Ballot
Lesson 1.3 English Language Arts	Lost at Sea *Students read and analyze excerpts from the novel* Life of Pi *by Yann Martel, and discuss the use of figurative language in creating vivid narrative. Students will write their own fictional narrative of travel aboard the ship they design in Subunit 3.*	• Lesson plan • Reading: The Open Boat • Reading: Life of Pi • Handout: Literary Devices • Handout: Vocabulary Cards • Handout: Sailing Short Story Assignment
Lesson 1.4 World or U.S. History	Storming the Beach *Students study the invasion of Normandy, including the engineering innovations (e.g., the Higgins boat) designed to overcome the beachhead defenses planned by Field Marshal Rommel.*	• Lesson plan • Map: Europe 1943 • Map: World 1943 • Handout: Med Invasion Analysis • Various primary sources
Subunit 2 Overview	**Sink or Swim**	
Lesson 2.1 Physics or Physical Science	Denser Sensor *Students explore the concept of density through a variety of hands-on experiments and demonstrations.*	• Lesson plan • Handout: Pop Prediction • Handout: Density Lab
Lesson 2.2 Physics or Physical Science	Archimedes' Principle *Students are introduced to the concept of buoyant force and the theory behind boats made from materials that have high density.*	• Lesson plan • PowerPoint: Buoyant Force • Handout: Loaded Dice • PowerPoint: Stability

Lesson 2.3 Biology	A Sinking Feeling *Students learn how marine life can control their buoyancy through manipulation of an organ known as the swim bladder. Students compare this ability to that of modern day submarines.*	• Lesson plan • PowerPoint: Do Fish Need Water Wings? • Handout: Submarine Challenge • Handout: Swim Bladder
Lesson 2.4 Geometry	3D Solids *Students learn to make and measure the surface area and volume of a variety of 3D solids.*	• Lesson plan • Handout: Ship Geometry • Handout: Ship Size
Lesson 2.5 Geometry or Algebra I	Container Ship Challenge *Students apply their knowledge of forces and volume to the practical challenge of building a seaworthy aluminum foil container ship model that provides the greatest shipping profit at the lowest building cost.*	• Lesson plan • Handout: Basic Cargo Ship Challenge

Subunit 3 Overview — Float Your Boat

Lesson 3.1 World Geography	Boats Far and Wide *Students are broken into groups to research and report on the history of sea travel and ship design in various regions around the world.*	• Lesson plan • Handout: Research Assignment
Lesson 3.2 Introduction to Engineering Design	Hull Design *Students are provided with the culminating design challenge options. In groups, they use the engineering design process to develop a hull design fulfilling a complicated set of design constraints provided in the ship design challenges. Students use Autodesk Inventor to create a 3D model and multi-view sketches of their design.*	• Lesson plan • Handout: Ship Shape Design Challenge • Handout: Design Briefs (4)
Lesson 3.3 English Language Arts	Making a Bid *Students write a technical document describing the design of their ship and how it fulfills the design constraints. Students present these proposals as if making a contract bid.*	• Lesson plan • Handout: Making a Bid • Handout: Proposal Assignment
Lesson 3.4 Introduction to Engineering Design	Launch Day *Students build their ship models and discover if they're seaworthy.*	• Lesson plan

National Standards Alignment

English	Mathematics	Social Studies	Science	Engineering
NCTE Standard 1 Standard 2 Standard 3 Standard 4 Standard 5 Standard 6 Standard 7 Standard 8 Standard 12	*NCTM Geometry* • Properties of geometric shapes • Visualization and spatial reasoning *NCTM Algebra* • Representative mathematical models • Change analysis	*NCSS* Standard 6D Standard 6F Standard 6G *NCHS World History* Era 8—Standard 3 Era 8—Standard 3B	*NRC Physical Science* Structures and properties of matter *NRC Life Science* Behavior of organisms	*ITEA* Standard 1 Standard 2 Standard 3 Standard 4 Standard 8 Standard 9 Standard 10 Standard 11 Standard 18 Standard 20

Reverse Engineering

Integrated Curriculum Unit for Introduction to Engineering Design

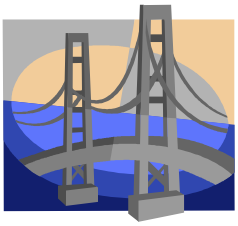
This integrated unit focuses on the theme of design engineering. Students are introduced to both design engineering and the process of reverse engineering in research and development. Students study the historical impact of a classic example of reverse engineering, the Enigma machine. The unit culminates in the tear down and redesign of a common household mechanical object.

Lessons		Curriculum Materials
Lesson 1 Introduction to Engineering Design	Introduction to Reverse Engineering *Students are introduced to the concept of reverse engineering and the associated integrated unit. Students will learn the definitions of basic terminology essential to their understanding of the visual language of design in order to communicate what they see, as well as how to identify the elements of design, or the components that form the structure of a product or an object, by studying products or objects common to their environment. They will also be introduced to the principles of design, the concepts used to organize the structural elements of a product or object.*	• Lesson plan • Presentation: Visual Design Principles • Worksheet: Visual Design Principles
Lesson 2 English Language Arts	Precision Communication *Students will learn characteristics of good technical writing and then critique a piece of technical writing based on those characteristics. Students will then apply that knowledge when writing their own technical document concerning the assembly of a multipart object they create.*	• Lesson plan • Presentation: Don't Be That Writer • Handouts: Excessive Documentation, Instruction Manual Example, What is Good Writing • Reading: Technical Documentation • Worksheet: Instructions Critique
Lesson 3 Introduction to Engineering Design	Functional Analysis *This lesson is the placeholder IED Lesson 3.2. In this lesson, students are guided through the functional analysis phase of the reverse engineering process. Students will learn about simple machines and use that knowledge to identify how the various components within their products function. Students will then generate summaries of the sequential operations of their products and identify the inputs and outputs that are indicative of those systems.*	• Lesson plan • Presentation: Simple Machines • Presentation: Reverse Engineering • Handouts: IED Lesson 3.2.x
Lesson 4 English Language Arts	The Design of Everyday Things *Students will learn about the function that the illustrative story can serve in informational writing. Students will read excerpts from The Design of Everyday Things and identify how the stories the author intersperses in the text help to engage his audience and illustrate his points. Students will then write illustrative stories of their own based on experiences with poor design.*	• Lesson plan • Worksheet: Anecdotes • Writing Assignment and Rubric: Illustrative Anecdote
Lesson 5 World History	Cracking the Enigma *In this lesson, students will analyze the necessity for and outcomes of technological innovations on the course of World War II. Students begin by learning about Enigma encryption and code-breaking during World War II, and then independently research other technological innovations and their impact on events of that time.*	• Lesson plan • Template: Cipher Rotors • Handouts and Answer Keys: Intercepted Message A, B, and C • Assignment and Rubric: Technological Innovation Report

Lesson 6 Algebra I	The Function of Codes *This lesson introduces students to functions as a subset of mathematical relations. In this lesson, students learn the characteristics of functions and how to read function notation. They then learn how to calculate inverse functions in the context of decoding messages.*	• Lesson plan • Worksheet: Is it a Function? • Worksheet: The Function of Codes
Lesson 7 Algebra I	Let Me Count the Ways *Students review the mathematical differences between permutations and combinations and learn how the two concepts are related. The different calculations that are necessary when repeats are allowed in a permutation or combination are also discussed. The class will then calculate the number of possible configurations for the actual Enigma machine.*	• Lesson plan • Worksheets and Answer Keys: Permutations and Combinations, Enigma Permutations, Enigma Combinations
Lesson 8 Biology	Science as Reverse Engineering *In this lesson, students learn how reverse engineering and scientific investigation often use similar methodologies to understand and characterize how things work. This lesson uses natural selection and adaptations as an example, but it would work just as well with almost any biological phenomenon.*	• Lesson plan • Background Reading: Reverse Engineering vs. Science • Worksheet: Functional Analysis
Lesson 9 Introduction to Engineering Design	Product Redesign *This lesson is a placeholder for IED Lessons 3.3 and 3.4. In this lesson, students will tear down a sample product and then identify specific visual, structural, or functional issues with their "reverse-engineered" products; initiate product improvements by writing design briefs; participate in group brainstorming sessions to develop creative ideas; use matrices to make design decisions; develop innovative solutions; and communicate their designs through technical reports.*	• Lesson plan • Presentations: Writing a Design Brief, Technical Report Writing • Worksheets: IED 3.3.x and 3.4.x

National Standards Alignment

English Language Arts	Mathematics	Social Studies	Science	Engineering
NCTE Standard 1 Standard 3 Standard 4 Standard 5 Standard 6 Standard 7 Standard 8 Standard 11 Standard 12	*NCTM Algebra* • Understand patterns, relations, and functions • Identify functions as linear or nonlinear and contrast their properties from tables, graphs, or equations • Understand and perform transformations such as arithmetically combining, composing, and inverting commonly used functions, using technology to perform such operations on more complicated symbolic expressions • Develop an understanding of permutations and combinations as counting techniques	*NCHS World History* Era 8, Standard 5 *NCHS U.S. History* Era 8, Standard 3	*NRC Science Perspectives* • Science and technology in local, national, and global challenges *NRC History and Nature of Science* • Science as a human endeavor • Nature of scientific knowledge	*ITEA* Standard 1 Standard 2 Standard 3 Standard 4 Standard 5 Standard 6 Standard 7 Standard 8 Standard 9 Standard 10 Standard 11



Bridge Builder

Integrated Curriculum Unit for Principles of Engineering

This integrated unit focuses on the theme of bridge building. Students are introduced to the application physics and trigonometry in bridge engineering, as well as the potential ecological impact of large scale construction. The building of the Brooklyn Bridge serves as a case study for students to examine geographic, political, and technological change in Gilded Age. The unit culminates in a design challenge where students design, build, and test balsa wood truss bridges.

Subunit 1 Overview	Form and Function	Curriculum Materials
Lesson 1.1 Principles of Engineering	Introduction to Bridges *Students are introduced to the unit and the culminating project. Students begin the unit with an introduction to the four major types of bridges, how they differ structurally, and their comparative advantages and disadvantages.*	• Lesson plan • PowerPoint: Intro to Bridges • Lab: Mini Models • Worksheet: Bridge Classification and Scavenger Hunt
Lesson 1.2 English Language Arts	Great Bridges *Students read and discuss excerpts from David McCullough's novel, The Great Bridge: The Epic Story of the Building of the Brooklyn Bridge. Each student selects and researches the history of famous bridge. Students synthesize their research into a historical narrative about their selected bridge.*	• Lesson plan • Reading: The Great Bridge • Handout: Historical Narratives
Lesson 1.3 U.S. History	Growth in the Gilded Age *Students examine historical maps of New York City to identify the patterns of New York City's rapid urbanization in the 19th Century and use those patterns to justify the need for bridges at specific locations.*	• Lesson plan • Maps: New York City 1642–1916 • Reading: Bridging the East River • Reading: The Big Bridge Scheme
Lesson 1.4 English Language Arts	Site Selection *Students break into groups to read and analyze the site selection reports from a number of different bridges. Through interpretation of these technical reports, students will identify key factors that affect the selection of a site for bridge construction.*	• Report: Columbia River Crossing Study • Handout: Interpreting the Table of Contents
Lesson 1.5 Biology or Earth Science	Environmental Mitigation *Students learn about various environmental factors that must be considered when beginning a major bridge construction, both in where the bridge is placed and what impact the bridge will have on the surrounding environment. Students also study the process by which environmental mitigation is planned to offset the impact of the construction.*	• Lesson plan • Demonstration: Wetland Sponge • Reading: Wetland Compensatory Mitigation
Subunit 2 Overview	**Structural Support**	
Lesson 2.1 Physics or Mathematics	Science of Bridge Structure *Students are introduced to the physics and math associated with calculating the forces on a truss bridge. This lesson covers content previously taught in Principles of Engineering lesson 5.1, but it can be covered by either the physics or math teacher.*	• Lesson plan • PowerPoint: Truss Bridge • Lab: Reaction Forces • Worksheet: West Point Bridge Design
Lesson 2.2 Algebra	Estimating Live Loads *Students estimate and graph the number of cars and busses that would fill a bridge span given the average lengths of each type of vehicle. They express the relationship between the number of different vehicles and the live load on the bridge as a graph and an equation. The class then finds the range of live load that the bridge would be expected to withstand.*	• Lesson plan • Lab: How Many Vehicles? • Worksheet: Estimating Live Loads

Lesson 2.3 Chemistry	Rusty Truss *Students investigate the corrosion of metals in a lab in order to identify various factors that contribute to the corrosion process.. Students conclude by researching and reporting on how actual bridges are protected and maintained from corrosion.*	• Lesson plan • Lab: Corrosion Chemistry • Reading: Steel Bridge Corrosion
Lesson 2.4 English Language Arts	Bridge Disaster News Report *Students watch footage of the Tacoma Narrows Bridge collapse and read newspaper accounts of the event. Students will then research a different bridge collapse and write their own news accounts of the disaster and the subsequent investigation.*	• Lesson plan • Video: Tacoma Narrows Bridge • Handout: Reporting the News

Subunit 3 Overview — Build Your Bridge

Lesson 3.1 U.S. History	Building the Brooklyn Bridge *Students investigate how the political machine of the era influenced building projects like the Brooklyn Bridge. Students also analyze the dilemmas facing American workers seeking to improve working conditions in the 19th century by researching and role-playing the caisson workers strike during the construction of the Brooklyn Bridge.*	• Lesson plan • Handout: 19th Century Commercials • Reading: Bridge Innovations • Handout: Bridge Strike Roleplay
Lesson 3.2 Principles of Engineering	Bridge Blueprints *Students are provided with the design constraints for the culminating project. Students design their bridges using 3D modeling software, and use the software to conduct stress analysis on their design. Students revise and retest their designs before building in-class building begins.*	• Lesson plan • Handout: Truss Designs • Handout: Bridge Project Design Brief
Lesson 3.3 Principles of Engineering	Opening Day *Students build their bridge designs out of balsa wood and test them for strength against their classmates.*	• Lesson plan

National Standards Alignment

English Language Arts	Mathematics	Social Studies	Science	Engineering
NCTE Standard 1 Standard 3 Standard 4 Standard 5 Standard 6 Standard 7 Standard 8 Standard 11 Standard 12	*NCTM Algebra* Understand patterns, relations, and functions Represent and analyze mathematical situations and structures using algebraic symbols *NCTM Geometry* Use visualization, spatial reasoning, and geometric modeling to solve problems	*NCHS World History* Era 8, Standard 2 Era 8, Standard 4 Era 9, Standard 1 Era 9, Standard 2 Era 9, Standard 3 *NCHS U.S. History* Era 8, Standard 3 Era 9, Standard 2 Era 10, Standard 1	*NRC Physical Science 9-12* Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship F = ma, which is independent of the nature of the force. Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object.	*ITEA* Standard 1 Standard 2 Standard 3 Standard 4 Standard 8 Standard 9 Standard 10 Standard 11 Standard 18 Standard 20

Bombs Away

Integrated Curriculum Unit for Principles of Engineering

This integrated unit focuses on the theme of ballistic motion. Students are introduced to the science and math that govern objects that follow a ballistic trajectory, and examine the history of various ballistic weapons use in conflicts of the 20th century, including evaluation of the rationale and the ethical issues surrounding the aftermath. The unit culminates in a design challenge where students design their own adjustable ballistic device and compete against each other in a Battleship game.

Subunit 1 Overview	Ready, Aim, Fire	Curriculum Materials
Lesson 1.1 Principles of Engineering	Ballistic Bullseye *Students are introduced to the unit, the culminating project, and examples of ballistic motion in the real world.*	• Lesson plan
Lesson 1.2 Physical Science or Principles of Engineering	Trajectory Motion *Students learn the basic principles behind kinematics and trajectory motion. Students apply those principles to make predictions and solve trajectory motion problems.*	• Lesson plan • Presentation: Kinematics • Handout: Projectile Motion Variables
Lesson 1.3 Algebra I or Geometry	"Qannon" Quadratics *Students apply knowledge of angles, trigonometric functions, and linear and quadratic equations to solve projectile motion problems. Students will be given a variety of scenarios where they must apply the formulas for projectile motion to determine angle, distance, or initial force at launch in order to hit a target with given parameters. Students will begin by practicing some problems as a class and then pair off to compete against each other in solving equations.*	• Lesson plan • Worksheet and Key: Vertical Motion Problems • Worksheet and Answer Keys: Prep Problems, Target Practice, Bad Neighbors, Mountain Matchup, Siege
Lesson 1.4 English Language Arts	Rocket Boys *Students read discuss excerpts from an account of building and testing model rockets in high school by Homer Hickam.*	• Lesson plan • Discussion Questions • Writing: Biographies
Subunit 2 Overview	**The Price of War**	
Lesson 2.1 World History	The Battle of Britain *Students research the events leading up the Battle of Britain from both side of the conflict, and then collaborate to create an annotated timeline of key events from July 10, 1840 to October 12, 1940.*	• Lesson plan • Timelines: Iraq War and Battle of Britain • Resource Guides: Battle of Britain strategies
Lesson 2.2 World History	Right or Might? *Students begin by distinguishing between tactical and strategic bombing strategies during military action. Students then evaluate the controversial decision to bomb the city of Dresden in German in 1945 after studying both primary documents and subsequent analysis of the reasoning behind and aftermath of the bombing.*	• Lesson plan • Key Vocabulary: Right or Might? • Readings and Guides: Dresden Bombing, Accounts, and Aftermath • Worksheet: Bombing Strategies • Essay: Dresden Decision Do-over
Lesson 2.3 English Language Arts	Making a Case *Students practice the fundamental debate skills of making and refuting an argument. Students then put these skills to practice in researching and debating a series of resolutions regarding the use of bombing near civilian populations in conflicts including and since World War II.*	• Lesson plan • Handout: Making a Case • Worksheet: Debate Research • Rubric: Debate • Guide: Sample Debate

Subunit 3 Overview — Too Close for Comfort

Lesson 3.1 Geometry	Ballistic Missile Range *Having learned the calculations for ballistic motion at short range (where the Earth is effectively flat), student now apply basic trigonometry to determine the range of ballistic missiles, accounting for the curvature of the Earth.*	• Lesson plan • Background: Ballistic Missiles • Worksheets: Arc Length, Ballistic Missile Range, Ballistic Missile Problems
Lesson 3.2 U.S. or World History	Cuban Missile Crisis *Groups of students each take on the role of key figure during the Cuban Missile Crisis and analyze the various strategies and likely consequences under consideration during the event. Lesson may be extended to have students compare their experience to the current situation of the United States in the Middle East.*	• Lesson plan • Roles: Panel Discussion • Chart: Reasons for Cuban Missile Crisis • Readings: Cuban Missile Crisis, ExComm Members, Kennedy's Decision, Global Consequences • Worksheet Crisis Reenactment • Rubric: Cuban Missile Crisis Essay
Lesson 3.3 Principles of Engineering	You Sunk My Battleship *Students design and build a ballistic ping-pong device based on a design brief. Students test their design and calculations In class. After the initial testing is complete, students mount their devices on "battleships" and then compete against each in pairs and teams. At the end of the competition, students will submit a written evaluation of their design and as well as a creative narrative of the battle.*	• Lesson plan • Activity: Battleship Competition • Design Brief: Ballistic Device Project • Rubric: Ballistic Device Project and Report

National Standards Alignment

English Language Arts	Mathematics	Social Studies	Science	Engineering
NCTE Standard 1 Standard 3 Standard 4 Standard 5 Standard 6 Standard 7 Standard 8 Standard 11 Standard 12	*NCTM Algebra* • Understand patterns, relations, and functions • Represent and analyze mathematical situations and structures using algebraic symbols • Use mathematical models to represent and understand quantitative relationships *NCTM Geometry* • Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships • Specify locations and describe spatial relationships using coordinate geometry and other representational systems • Use visualization, spatial reasoning, and geometric modeling to solve problems	*NCHS World History* Era 8, Standard 2 Era 8, Standard 4 Era 9, Standard 1 Era 9, Standard 2 Era 9, Standard 3 *NCHS U.S. History* Era 8, Standard 3 Era 9, Standard 2 Era 10, Standard 1	*NRC Physical Science* Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship F = ma, which is independent of the nature of the force. Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object.	*ITEA* Standard 1 Standard 2 Standard 3 Standard 4 Standard 8 Standard 9 Standard 10 Standard 11 Standard 18 Standard 20

Green Design

Integrated Curriculum Unit for Civil Engineering and Architecture

This integrated unit focuses on environmental considerations associated with design and engineering of building. Students begin by exploring contemporary concerns about renewability of resources and energy consumption. Students use this context to investigate the different building technologies in use and under development that will address the need and desire for energy and resource efficiency in current and future construction. The unit culminates with a project that has students synthesize their learning from CEA and their academic classes to design and present plans for a LEED-certified addition to their school or other local building.

Subunit 1 Overview — World in Balance

Lesson 1.1
Civil Engineering and Architecture

Building Big
Students are introduced the unit and the design challenge of the unit. Students are also introduced to the concept of energy efficiency and LEED certification and explore the various categories associated with LEED-certification for school buildings. Standard CEA lessons will be taught throughout this integrated unit.

Lesson 1.2
Science

Power Up
Students begin with a estimation of their own carbon footprint and discuss why this calculation can be very complex considering goods used in the United States can come from all over the world. Students also investigate the common ways energy is produced and harnessed in the U.S. and around the world, and the various effects of energy production to local environments. The lesson concludes with a comparison the advantages and disadvantages of using the available renewable vs. nonrenewable resources.

Lesson 1.3
Social Studies

Energy Crisis: Past, Present, and Future
Students research the growth of U.S. and world energy production and consumption of the past 50 years. Students compare and contrast the causes and effects of the oil crises of 1973 and 1979 to the events of today, and anticipate the impact that the rising economies of Asia, South America, and Africa will have on the energy market. Students debate how environmental standards should be applied to developing versus developed nations.

Lesson 1.4
Science

Where is the Water?
Students begin by learning about water conservation issues at the local, national, and global levels. Students calculate their own water usage, propose plans of personal water conservation, and then extrapolate the savings if a community or nationwide scale up of such measures were to occur. Students also conduct tests of local water quality and do experiments around wastewater treatment.

Lesson 1.5
English Language Arts

Life Without Oil
Presented with a scenario of rapidly decreasing amounts of our primary fuel source, students are asked to imagine and then document different aspects of life under these new conditions using a variety of written and visual media.

Subunit 2 Overview — Project Planning

Lesson 2.1
English Language Arts

Who Wants What?
Students research the space needs of the school (or community) by designing and conducting survey interviews of key stakeholders around the school. This information is used to conduct a design charrette with actual stakeholders or with students taking on the role of key stakeholders. Students summarize their findings in a written report.

Lesson 2.2
Science

Breathe Deep
Students research different factors that affect indoor air quality, including chemical composition of the air, temperature, and humidity. Students conduct experiments to measure the CO_2 levels and ventilation in various spaces around the school and determine appropriate ventilation rates.

Lesson 2.3 Science	Cool Heat *Students explore the thermodynamic principles that govern heat flow and transfer, and apply them to the heat sources and HVAC system present in the school.*
Lesson 2.4 Mathematics	Lot Plot *Students use trigonometry to survey and plot the site of the building project as well as take interior measurements of an existing building section for possible remodeling.*

Subunit 3 Overview — Going Green

Lesson 3.1 Social Studies	Rising to the Challenge *Students examine and evaluate the different reactions of various countries to past energy shortages. Based on research on prior effective strategies and new alternatives currently under consideration, students propose their own directions for future U.S. energy policy.*
Lesson 3.2 English Language Arts	From Technology to Design *Students read excerpts from* The Cloud Sketcher *by Richard Rayner. The novel intertwines story of budding architect, Esko Vaananen, and the invention of the elevator, which opened up the field of skyscraper design. Students analyze how the buildings designed by the protagonist reflect both his character and the era, and compare those technological and design advances with the current green design movement prevalent today.*
Lesson 3.3 Mathematics	Lighting Strategies *Students learn how lightshelves and sloped ceilings can be used to reduce light differentials in interior spaces while reducing glare and solar heat gain. Students calculate optimal lengths and angles of for exterior shading, optical lightshelves and ceilings given the location of their site.*
Lesson 3.4 Civil Engineering and Architecture	Renewable Building Materials *Students research the materials used in construction, including how the most common are produced/harvested, their renewable and/or recycled alternatives, and how their various costs and benefits.*
Lesson 3.5 Science	Pushing the Envelope *Students apply their knowledge of thermal conductivity and radiance to design the building envelope for maximum energy efficiency.*
Lesson 3.6 Civil Engineering and Architecture	Project Presentation *Students present their final designs to a panel of key stakeholders in the school or community. Presentations include needs survey, overall design concept, plans for floor, plot, landscape, foundation, plumbing, electrical, HVAC, and truss, elevations, sections, 3D perspectives, and explanation of LEED-certification features.*

National Standards Alignment

English Language Arts	Mathematics	Social Studies	Science	Engineering
NCTE Standard 1 Standard 3 Standard 4 Standard 5 Standard 6 Standard 7 Standard 8 Standard 11 Standard 12	*NCTM Geometry* • Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships • Specify locations and describe spatial relationships using coordinate geometry and other representational systems • Use visualization, spatial reasoning, and geometric modeling to solve problems	*NCHS World History* Era 9, Standard 1 Era 9, Standard 2 Era 9, Standard 3 *NCHS U.S. History* Era 10, Standard 1	*NRC Science as Inquiry* • Abilities necessary to do scientific inquiry • Understanding about scientific inquiry *NRC Physical Science* • Conservation of energy and increase in disorder • Interactions of energy and matter *NRC Science Perspectives* • Natural and human-induced hazards	*ITEA* Standard 1 Standard 2 Standard 3 Standard 5 Standard 6 Standard 8 Standard 9 Standard 11 Standard 16

ConnectEd
The California Center for College and Career

Transforming today's education
for tomorrow's economy

ConnectEd's mission is to support the development of Linked Learning and the pathways by which California's young people can complete high school, enroll in postsecondary education, attain a formal credential, and embark on lasting success in the world of work, civic affairs, and family life.

Expanded Summary of Curriculum Units:
Engineering Program of Study Integrated Curriculum Units

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