SYSTEMS

OVERVIEW

ENDURING UNDERSTANDINGS

Unit 4, Systems, focuses on 3 main Enduring Understandings. As students complete the lessons and activities, they will understand:

- That systems are comprised of nine core technologies.
- That the universal systems model governs the operation of all systems.
- That reverse engineering and troubleshooting allow engineers to solve problems and issues that arise from the development of systems.

BIG IDEA

Systems are the building blocks of technology and users must properly maintain, troubleshoot, and analyze systems to ensure safe and proper function.

Teacher's Note
Big ideas should be made explicit to students by writing them on the board, reading them aloud, and/or posting them on worksheets associated with the lessons. For deeper understanding, have students write the Big Idea in their own Engineering Design Journal (EDJ), using their own words if they choose.

PURPOSE OF THE UNIT

This unit will enable students to identify the core technologies, subsystems, and systems that make up technological devices, reverse engineer a product, and to diagnose problems when they occur through troubleshooting techniques.

INSTRUCTIONAL TIME

Unit 4 requires 9.5 weeks of instructional time based on one hour per day. Each of the four units in the Invention and Innovation s course require the following number of hours to cover the content:

REQUIRED UNIT HOURS	ENRICHMENT HOURS	TOTAL UNIT HOURS	TOTAL UNIT WEEKS
30 Hours	17 Hours	47 Hours	9.5 Weeks

STANDARDS AND BENCHMARKS THAT ARE ADDRESSED

This unit is based on three sets of Standards:

1. Standards for Technological Literacy (STL)
2. Next Generation Science Standards (NGSS)
3. Common Core State Standards (CCSS)

TECHNOLOGY: Standards for Technological Literacy (STL) *(ITEA/ITEEA, 2000/2002/2007)*	
STL 1	**Students will develop an understanding of the characteristics and scope of technology.**
J	The nature and development of technological knowledge and processes are functions of the setting.
STL 2	**Students will develop an understanding of the core concepts of technology.**
J	The nature and development of technological knowledge and processes are functions of the setting.
STL 12	**Students will develop the abilities to use and maintain technological products and systems.**
M	Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.
N	Troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision.
O	Operate systems so that they function in the way they were designed.
STL 14	**Students will develop an understanding of and be able to select and use medical technologies.**
L	Telemedicine reflects the convergence of technological advances in a number of fields, including medicine, telecommunications, virtual presence, computer engineering, informatics, artificial intelligence, robotics, materials science, and perceptual psychology.
STL 15	**Students will develop an understanding of and be able to select and use agricultural and related biotechnologies.**
K	Agriculture includes a combination of businesses that use a wide array of products and systems to produce, process, and distribute food, fiber, fuel, chemical, and other useful products.
STL 16	**Students will develop an understanding of and be able to select and use energy and power technologies.**
J	Energy cannot be created nor destroyed; however, it can be converted from one form to another.
K	Energy can be grouped into major forms: thermal, radiant, electrical mechanical, chemical, nuclear, and others.
M	Energy resources can be renewable or nonrenewable.
N	Power systems must have a source of energy, a process, and loads.
STL 17	**Students will develop an understanding of and be able to select and use information and communication technologies.**
L	Information and communication technologies include the inputs, processes, and outputs associated with sending and receiving information.
M	Information and communication systems allow information to be transferred from human to human, human to machine, machine to human, and machine to machine.
N	Information and communication systems can be used to inform, persuade, entertain, control, manage, and educate.
O	Communication systems are made up of source, encoder, transmitter, receiver, decoder, storage, retrieval, and destination.
Q	Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.
STL 18	**Students will develop an understanding of and be able to select and use transportation technologies.**
J	Transportation plays a vital role in the operation of other technologies, such as manufacturing, construction, communication, health and safety, and agriculture.
STL 19	**Students will develop an understanding of and be able to select and use manufacturing technologies.**
M	Materials have different qualities and may be classified as natural, synthetic, or mixed.
O	Manufacturing systems may be classified into types, such as customized production, batch production, and continuous production.
P	The interchangeability of parts increases the effectiveness of manufacturing processes.
STL 20	**Students will develop an understanding of and be able to select and use construction technologies.**

J	Infrastructure is the underlying base or basic framework of a system.
K	Structures are constructed using a variety of processes and procedures.

***SCIENCE:* Next Generation Science Standards (NGSS, 2013)**	
HS-ETS1-2	**Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.**
HS-ETS1-3	**Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.**
HS-ETS1-4	**Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.**

***MATHEMATICS:* Common Core State Standards (CCSS, 2012)**	
MP.2	**Reason abstractly and quantitatively.**
MP.4	**Model with mathematics.**

***ENGLISH-LANGUAGE ARTS:* Common Core State Standards (CCSS, 2012)**	
RST.11-12.7	***Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.***
RST.11-12.8	**Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information**
RST.11-12.9	**Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.**

UNIT OBJECTIVES:

CYCLE	BIG IDEA	OBJECTIVES
Learning Cycle 1: Core Technologies (6 hours)	Every system and product is made up of one or more of the nine core technologies: bio-, electrical, electronic, fluid, material, mechanical, optical, structural, and thermal technology.	Explain that systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems.
		Use systems in the design and development of technology.
		Differentiate between larger technological, social, or environmental systems and smaller components and subsystems.
		Identify the various systems embedded within the larger system (technological, social, or environmental), using the language of the core technologies.
		Calculate algebraic equations representing scientific principles related to a design challenge to refine a solution to the problem.
		Contribute to a group endeavor by offering useful ideas, supporting the efforts of others, and focusing on the task.
		Work safely and accurately with a variety of tools, machines, and materials.

		Actively participate in group discussions, ideation exercises, and debates.
Learning Cycle 2 Universal Systems Model (4 hours)	The universal systems model—input, process, output, and feedback—helps users isolate the components of a system so that they may be properly used and maintained.	Operate systems so that they function in the way they were designed.
		Identify the safe procedures and directions so a new user can recognize the input, process, output, and feedback components of a system as well as how to operate it.
		Explain that systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems.
		Use systems in the design and development of technology.
		Differentiate between larger technological, social, or environmental systems from smaller components and subsystems.
		Identify the various systems embedded within the larger system (technological, social, or environmental), using the language of the core technologies (input, process, output, feedback).
		Design a troubleshooting diagram and manual for another user to maintain the safe and proper operation of a system or product.
		Actively participate in group discussions, ideation exercises, and debates.
Learning Cycle 3: Reverse Engineering (3 hours)	Companies use reverse engineering to analyze the functioning and manufacturing of a current product for product improvement and/or optimization.	Differentiate between larger technological, social, or environmental systems and smaller components and subsystems.
		Explain that systems fail because they have faulty or poorly matched parts, are used in ways that exceed what was intended by the design, or were poorly designed to begin with.
		Identify an opportunity for redesign of a product and choose to reverse engineer the design flaw.
		Define a system by identifying its subsystems, their relationship to other systems, and the intended input and output of the system.
		Contribute to a group endeavor by offering useful ideas, supporting the efforts of others, and focusing on the task.
		Work safely and accurately with a variety of tools, machines, and materials.
		Actively participate in group discussions, ideation exercises, and debates.
Learning Cycle 4 Troubleshooting (17 hours)	Troubleshooting allows users to continue to use and maintain the proper operation of a system or product.	Use tools, materials, machines, and knowledge to repair a system or product that is malfunctioning.
		Explain that systems fail because they have faulty or poorly matched parts, are used in ways that exceed what was intended by the design, or were poorly designed to begin with.
		Troubleshoot common mechanical and electrical systems, checking for possible causes of malfunction, and decide whether to fix it or get help from an expert.
		Design a troubleshooting diagram and manual for another user to maintain the safe and proper operation of a system or product.
		Troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision.
		Follow instructions in manuals or seek help from an experienced user to learn how to operate new mechanical or electrical devices.

		Diagnose a system that is malfunctioning and distinguish tools, materials, machines, and knowledge to repair it.
		Contribute to a group endeavor by offering useful ideas, supporting the efforts of others, and focusing on the task.
		Work safely and accurately with a variety of tools, machines, and materials.
		Actively participate in group discussions, ideation exercises, and debates.
Total for This Unit = 30 Hours plus 17 hours Enrichment		

ASSESSMENT TOOLS

Learning assessed using:

- Selected Response Items
- Brief Constructed Response Item
- Performance Rubrics

Specific tools are incorporated into each lesson as Supporting Files.