CAST's UDL LESSON BUILDER

Principle of Engineering Machine Control Lesson

Lesson Overview

Title:	Machine Control
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Subject:	Principles of Engineering
Grade Level(s):	10-12
Duration:	7 days
Subject Area:	Control Systems
Unit Description:	In this unit students will explore and gain an understanding of: · mechanical process control using computer software and hardware. · pneumatic and hydraulic power components related to the manipulation of work and power. · design problems related to control systems.
Lesson Description for Day:	Introduce the design project for the end of Lesson 3.1
State Standards:	See standards here

Goals

Unit Goals:	*It is expected that students will:* · Create detailed flow charts that utilize a computer

	software application. · Create control system operating programs that utilize computer software. · Create system control programs that utilize flowchart logic. · Choose appropriate input and output devices based on the need of a technological system. · Differentiate between the characteristics of digital and analog devices. · Judge between open and closed loop systems in order to choose the most appropriate system for a given technological problem.
Lesson Goal for Project 3.1.7:	Apply all of the unit goals to design and create a control system based on given needs and constraints.

Methods

Anticipatory Set:	Before beginning, elicit the following list of things that need brainstorming consideration when designing a control system: Open Loop or closed loop? How many motors? What variables do I need? What sensors? Building materials? What decisions will it need to make? Will it ever end? Analog or digital inputs?
Introduce and Model New Knowledge:	During activities 3.1.1 through 3.1.6 we introduced and modeled the new knowledge about control systems; this project applies that knowledge using the design process students have used for more than a year.
Provide Guided Practice:	Guided practice was provided in activities 3.1.1 through 3.1.6. The anticipatory set is also guided practice and a model for implementing the design process.
Provide Independent Practice:	Provide each student with copy of the problem choices and read through aloud together. Provide 10 minutes for students to brainstorm and explore possibilities individually. Group students based on the problems they chose and have them discuss their ideas. Discuss the expectations for product using rubric.

	Students have 6 days in class to complete the project and may come in during study hall, before and after school for more time to work or help.

Assessment

Formative/Ongoing Assessment:	Students must show their programming and build idea to me before they may begin building. If they can't articulate their plan, they need to continue working before they can begin to build their solution. I will ask questions to help guide them to a workable solution. Walk around during lab time answering questions and asking students to describe what they are working on.
Summative/End Of Lesson Assessment:	Students submit their engineering notebook and present their system to their classmates. See rubric.

Materials

Project 3.1.7 Machine Control Design Class website with concepts, key terms, objectives and essential questions and access to all related presentations and documents VEX building components RobotC software Rubric Students have graphs, charts and pictorial representations of control system design and programming strategies in their engineering notebooks along with their own notes from the presentations and activities 3.1.1 through 3.1.6.

Standards and Benchmarks Addressed

Standards for Technological Literacy

Standard 2:	Students will develop an understanding of the core concepts of technology.
BM Y:	The stability of the technological system is influenced by all of the components in the system, especially those in the feedback loop.
BM AA:	Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development
BM V:	Controls are mechanisms or particular steps that people perform using information about the system that causes systems to change.
BM BB:	Optimization is an ongoing process of methodology of designing or making a product and is dependent on criteria and constraints.
BM FF:	Complex systems have many layers of controls and feedback loops to provide information.

Standard 8:	Students will develop an understanding of the attributes of design.
BM H:	The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating the processes and results.
BM I:	Design problems are seldom presented in a clearly defined form.
BM J:	The design needs to be continually checked and critiqued, and the ideas of the design must be refined and improved.
BM K:	Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.
Standard 9:	Students will develop an understanding of engineering design.
BM F:	Design involves a set of steps which can be performed in different sequences and repeated as needed
BM J:	Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.
BM L:	The process of engineering design takes into account a number of factors.
Standard 10:	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
BM F:	Troubleshooting is a problem-solving method used to identify the cause of a malfunction in technological system.
Standard 11:	Students will develop abilities to apply the design process.
BM M:	Identify the design problem to solve and decide whether or not address it
BM N:	Identify criteria and constraints and determine how these will affect the design process.
BM Q:	Develop and produce a product or system using a design process.
Standard 16:	Students will develop an understanding of and be able to select and use energy and power technologies.
BM N:	Power systems must have a source of energy, a process, and loads.
Standard 17:	Students will develop an understanding of and be able to select and use information and communication technologies.
BM L:	Information and communication technologies include the inputs, processes, and outputs associated with sending and receiving information.
BM M:	Information and communications systems allow information to be transferred from human to human, human to machine, and machine to machine.
BM 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.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades 9-12, all students should develop understanding and abilities aligned with the following concepts and processes

- **Change, constancy, and measurement**
- **Evidence, models, and explanation**
- **Change, constancy, and measurement**
- **Form and function**

Science as Inquiry Standard B: As a result of activities in grades 9-12, all students should develop an understanding of

- **Motions and forces**

Science and Technology Standard E: As a result of activities in grades 9-12, all students should develop

- **Abilities of technological design**

Principles and Standards for School Mathematics

Algebra Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to understand patterns, relations, and functions; and represent and analyze mathematical situations and structures using algebraic symbols.
Problem Solving Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to build new mathematical knowledge through problem solving.
Connections Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to recognize and apply mathematics in contexts outside of mathematics.
Representation Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to create and use representations to organize, record, and communicate mathematical ideas; select, apply, and translate among mathematical representations to solve problems; use representations to model and interpret physical, social, and mathematical problems.

Standards for the English Language Arts

Standard 4:	Students adjust their use of spoken, written, and visual language (e.g. conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Rubric

Design

Topics	4 points	3 points	2 points	1 point
Two Potential Physical Solutions	Produces accurate sketches that meet the required design concepts. Is properly detailed for effective communication, including labels,	Produces marginally sufficient sketches that meet the required design concepts. Is properly detailed for effective communication,	Produces sketches that are difficult to visualize. Lacks details in sketches. Missing some details for effective communication,	Produces incomplete sketches. Does not present the concept well. Missing several details for effective communication, including labels,

	descriptions, signatures, and dates.	including labels, descriptions, signatures, and dates.	including labels, descriptions, signatures, and dates.	descriptions, signatures, and dates.
Two Potential Program Solutions	Produces accurate program solutions. Is properly detailed for effective communication, including labels, descriptions, signatures, and dates.	Produces marginally sufficient program solutions that meet the required design concepts. Is properly detailed for effective communication, including labels, descriptions, signatures, and dates.	Produces program solutions that are difficult to visualize. Lacks details in sketches. Missing some details for effective communication, including labels, descriptions, signatures, and dates.	Produces incomplete program solutions that are difficult to visualize. Missing several details for effective communication, including labels, descriptions, signatures, and dates.
Final Physical Solution Concept Sketch or 3D Model	Solution is accurate and includes a high-quality sketch or 3D model. Meets the required design concepts.	Solution is mostly accurate and includes a high-quality sketch or 3D model. Meets most of the required design concepts.	Solution is somewhat accurate and includes a medium-quality sketch or 3D model. Meets some of the required design concepts.	Solution is not accurate and includes a medium-quality sketch or 3D model. Meets some of the required design concepts.
Final Physical Solution Concept Written Communication	Includes details for effective communication, including labels, descriptions, signatures, and dates.	Includes most details for effective communication, including labels, descriptions, signatures, and dates.	Is missing many details for effective communication, including labels, descriptions, signatures, and dates.	Is missing most details for effective communication, including labels, descriptions, signatures, and dates.

Physical Solution

Topics	4 points	3 points	2 points	1 point
Design Requirements	Fully meets design requirements.	Meets most design requirements and supports the design function.	Meets some requirements but not enough to support the design function.	Does not meet design requirements.
Quality and Functionality	Mechanism functions correctly, consistently, and the chosen parts are appropriate.	Mechanism functions most of the time, and the chosen parts are appropriate.	Mechanism sometimes functions, and the parts are not chosen appropriately.	Mechanism rarely functions, and the parts are not chosen appropriately.

Program Solution

Topics	4 points	3 points	2 points	1 point
Design Requirements	Fully meets design requirements.	Meets most design requirements and supports the design function.	Meets some requirements but not enough to support the design function.	Does not meet design requirements.
Quality and Functionality	Works correctly, consistently, and function blocks are well chosen.	Works most of the time, and most function blocks are well chosen.	Works inconsistently, and most function blocks are well chosen.	Contains errors as a result of poorly chosen function blocks.

Engineering Notebook

Topics	4 points	3 points	2 points	1 point	0 points
Table of Contents	Table of contents is accurate and up to date	Failure to update your table of contents will result in ZERO points for the engineering			Table of contents is not accurate and up to date

		notebook rubric.			
Signatures and Dates	Every full page is signed by the author and witness and the dates agree	1 full page is not signed by the author or witness or dates do not agree	More than one page is missing a signature or date		No signatures and dates
Chronological Order	Every artifact is written or glued into the e-notebook in the order in which it was made	1 artifact is out of order OR signature and date do not agree	1 artifact is out of order AND signature and date do not agree	More than 1 artifact is out of order AND signatures and dates do not agree	Out of order
Journal Entries	Journal entries are made every day and include dates, a description of accomplishments and failures during work time and goals or plans for future work	Journal entries are made every day but one and include dates, a description of accomplishments and failures during work time and goals or plans for future work	Journal entries are not made every day OR do not include dates, description of accomplishments and failures during work time and goals or plans for future work	Journal entries are not made every day AND do not include all necessary information	No journal entries
Neat, legible and understandable	Drawings, notations and writing are neat, legible and understandable	Most drawings, notations and writing are neat, legible and understandable	Some drawings, notations and writing are neat, legible and understandable	Very little drawings, notations and writing are neat, legible and understandable	Nothing is neat, legible and understandable

Total rubric = 52 * 2 = 104 points
Demonstration = 20 points
Conclusion question = 6 points*
Total Points = 130
Demonstration = 20 points based on the following:
Introduction introduces the teammates and describes the problem
Demonstration works first time
Demonstration does not require human interaction beyond that which is called for in the problem
*Conclusion questions should be answered in your engineering notebook.
Conclusion ends the demonstration
Overall demonstration is professional and engaging