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| **CIM Lesson Plan – Week 7-11** **Lesson 3.1 Introduction to Robotic Automation**  |

**Preface**

 What impact has automation made on your life? Everywhere you look, automation is at work. Doors open as you approach them. Elevators transport you from one floor of a building to another. Airports use automation to transfer your luggage and even your body.

The face of manufacturing has changed drastically with the advent of automation. Robots play a significant role in the process of automation.

In this lesson students will explore the history of automation and automation careers. They will use simulation software to program a virtual robot to perform various tasks commonly used in manufacturing.

**Concepts**

1.    Many factors have influenced the evolution of automation.

2.    A variety of automation careers exist.

3.    Robots are widely used in industry to assist in the production of manufactured goods.

4.    Robots have distinct advantages over humans in some industrial settings (e.g., hazardous environments, repetitive motion or long hours).

5.    Robots and machines communicate and coordinate their activities through a process called handshaking.

**Standards and Benchmarks Addressed**

***Standards for Technological Literacy***

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| **Standard 2:** | Students will develop an understanding of the core concepts of technology. |
| **BM Y:** | The stability of a technological system is influenced by all of the components in the system, especially those in the feedback loop.  |
| **BM Z:** | Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste. |
| **BM FF:** | Complex systems have many layers of controls and feedback loops to provide information. |
| **Standard 4:** | Students will develop an understanding of the cultural, social, economic, and political effects of technology. |
| **BM I:** | Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.  |
| **Standard 8:** | Students will develop an understanding of the attributes of design.   |
| **BM J:** | The design needs to be continually checked and critiqued, and the ideas of the design must be redefined 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 K:** | A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.   |
| **BM L:** | The process of engineering design takes into account a number of factors. |
| **Standard 11:** | Students will develop abilities to apply the design process.  |
| **BM R:** | Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models. |
| **Standard 12:** | Students will develop the abilities to use and maintain technological products and systems. |
| **BM L:** | Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques. |
| **BM O:** | Operate systems so that they function in the way they were designed. |
| **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 M:** | Information and communication systems allow information to be transferred from human to human, human to machine, machine to human, and machine to machine. |
| **BM O:** | Communication systems are made up of source, encoder, transmitter, receiver, decoder, storage, retrieval, and destination. |
| **BM P:** | There are many ways to communicate information, such as graphic and electronic means. |
| **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. |
| **Standard 18:** | Students will develop an understanding of and be able to select and use transportation technologies |
| **BM J:** | Transportation plays a vital role in the operation of other technologies, such as manufacturing, construction, communication, health and safety, and agriculture.  |
| **BM M:** | The design of intelligent and non-intelligent transportation systems depends on many processes and innovative techniques. |

***National Science Education Standards***

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

         **Abilities of technological design**

         **Understandings about science and technology**

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**Science in Personal and Social Perspectives Standard F:** As a result of activities in grades 9-12, all students should develop understanding of

         **Natural and human-induced hazards**

         **Science and technology in local, national, and global challenges**

**History and Nature of Science Standard G:** As a result of activities in grades 9-12, all students should develop understanding of

         **Science as a human endeavor**

         **Nature of scientific knowledge**

         **Historical perspectives**

***Principles and Standards for School Mathematics***

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| **Number and Operations:** | Instructional programs from pre-kindergarten through grade 12 should enable all students to; understand numbers, ways of representing numbers, relationships among numbers, and number systems; understand meanings of operations and how they relate to one another; compute fluently and make reasonable estimates. |
| **Algebra:** | Instructional programs from pre-kindergarten through grade 12 should enable all students to represent and analyze mathematical situations and structures using algebraic symbols, use mathematical models to represent and understand quantitative relationships, and analyze change in various contexts. |
| **Geometry**: | Instructional programs from pre-kindergarten through grade 12 should enable all students to 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; apply transformations and use symmetry to analyze mathematical situations; use visualization, spatial reasoning, and geometric modeling to solve problems. |

***Standards for English Language Arts***

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| **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. |
| **Standard 5:** | Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for a variety of purposes. |
| **Standard 7:**  | Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g. print and nonprint texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience. |
| **Standard 12:** | Students use spoken, written and visual language to accomplish their own purposes (e.g. for learning, enjoyment, persuasion, and the exchange of information). |

**Performance Objectives**

*It is expected that students will:*

         Research a topic in automation.

         Explore automation careers.

         Identify the advantages and disadvantages of robotic labor versus human labor.

         Explore materials handling.

         Create and program virtual robotic work cells with simulation software.

         Program the interface between a robot and another machine.

**Assessment**

*Explanation*

1.    Students will explain how a given historical automated device has influenced the development of automation.

2.    Students will identify the requirements for a career in automation, a starting salary, and benefits.

3.    Students will explain how automation is used in modern manufacturing.

4.    Students will explain the impact that automation has on the human worker.

5.    Students will explain the benefits of using simulation software.

*Application*

6.    Students will complete various activities using robotic simulation software.

7.    Students will model a virtual robot system that communicates with another machine.

*Empathy*

8.    Students will analyze a scenario and determine if a using a robot or human operator would be the best decision.

**Essential Questions**

1.    What were some early technologies that helped facilitate the development of robots?

2.    What are some examples and uses of early robots?

3.    Why are robots used in industry?

4.    What effect does the robot have on the human worker?

5.    What are the benefits of simulation software in industry?

6.    What situations require robots to communicate with machines?

**Key Terms**

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| **Automated Guided Vehicle (AGV)** | A driverless computer-controlled system, typically with a predefined path, that uses pallets and other interface equipment to transport workpieces to NC machine tools and other equipment in a flexible manufacturing system. |
| **Automated Storage and Retrieval System (ASRS)** | A system that moves material either vertically or horizontally between a storage compartment and a transfer station or within a process. |
| **Automation** | The use of technology to ease human labor or extend the mental or physical capabilities of humans. |
| **Computer Aided Manufacturing (CAM)** | The use of computers in converting engineering designs into finished products. |
| **Degrees of Freedom** | Motion variable for a robot axis; each requires a joint. |
| **Flexible Manufacturing System** | Groups of CNC machine tools that are highly integrated with automated material handling and computerized control systems. |
| **Gripper** | End effector that is designed to pick up, hold, and/or release an object or to move it. |
| **Inventory Control** | Systematic management of the balance on hand of inventory items, involving the supply, storage, distribution, and recording of items. |
| **Materials Handling** | The loading, moving, and unloading of materials. |
| **Robot** | A mechanical device that can be programmed to perform a variety of tasks of manipulation and locomotion under automatic control.  |
| **Robotics** | The science and technology of robots, their design, manufacture, and application. |
| **Servo Motor** | Any motor that is modified to give feedback concerning the motor's speed, direction of rotation, and number of revolutions. |
| **Stepper Motor** | Rotate in short and essentially uniform angular movements. These angles are typically 30, 45, or 90 degrees. |

**Day-by-Day Plans**

*Time: 19 Days*

**Day 1:**

         The teacher will present **Concepts,** **Key Terms**, and **Essential Questions** in order to provide a lesson overview.

         The teacher will present **Robotics Overview.ppt**slides 1-9.

         Students will take notes in their journals.

         The teacher will distribute **Project 3.1.1 History of Automation****.**

         Students will choose and research a topic.

         Students will complete research for **Project 3.1.1 History of Automation**.

**Day 2-3:**

         The teacher will distribute and discuss **RoboCell Background Information**sheet.

         The teacher will demonstrate how to use RoboCell simulation software. The teacher will show students how to record positions and write a program.

         Students will start **Activity 3.1.2a Pick and Place Routine****.**

         Students will complete **Activity 3.1.2a Pick and Place Routine**.

         The teacher will assess student programs on the computer.

**Day 4-6:**

         Students will complete**Activity 3.1.2b Teaching Positions****.**

         The teacher will assess student programs on the computer.

         The teacher will distribute the following activities for students to complete.

         **Activity 3.1.2c Stacking Objects**

         **Activity 3.1.2d Roll Angles**

         **Activity 3.1.2e Relative Positions**

         **Activity 3.1.2f Go Circular**

         **Work Envelope Paper**

**Day 7-8:**

         The teacher will distribute and discuss **Variable Programming** information sheet.

         The teacher will distribute the following activities for students to complete.

         **Activity 3.1.2g Variable Programming**

         **Activity 3.1.2h Palletization & Storage**

* Students will build a BOE-BOT robot and conduct program tests to insure proper assembly and setup.
* Students will learn the fundamentals of the BASIC programming language and write various programs to operate the BOE-BOT.
* Students will master intermediate level BASIC programming techniques, working with variables and subroutines.
* Students will learn to calibrate their BOE-BOT with BASIC to insure precise movement and timing.

**Day 9-19:**

BoeBot Activities

1. Run backwards for 6 seconds
2. Run forward for exactly 3 feet
3. Roaming with Whiskers
4. Roaming with Photoresistors
5. Following a flashlight with Photoresistors
6. Roaming with Infrared sensors
7. Drop off detector with IR
8. Distance detection with IR

**Day 20:**

         The teacher will present **Robots vs. Humans.ppt****.**

         Students will take notes using **Activity 3.1.3 Robots vs. Humans** as a guide.

         Students will complete the Conclusion questions for homework.

**Day 21:**

         The teacher will present **Materials Handling.ppt****.**

         Students will take notes using **Activity 3.1.4 Materials Handling** as a guide.

         Students will complete the Conclusion questions for homework.

**Instructional Resources**

Presentations

**Robots vs. Humans**

**Materials Handling**

**Robotics Overview**

Word Documents

**Project 3.1.1 History of Automation**

**RoboCell Background Information**

**Activity 3.1.2a Pick and Place Routine**

**Activity 3.1.2b Teaching Positions**

**Activity 3.1.2c Stacking Objects**

**Activity 3.1.2d Roll Angles**

**Activity 3.1.2e Relative Positions**

**Activity 3.1.2f Go Circular**

**Activity 3.1.2g Variable Programming**

**Activity 3.1.2h Palletization & Storage**

**Activity 3.1.3 Robots vs. Humans**

**Activity 3.1.4 Materials Handling**