ROI

INDIANA UPLANDS | PROUD PARTNER

Grade 3-5 STEM Challenge

Machining with Friends

Inspired by Cory, a CNC Machinist in the Indiana Uplands.

Published by Regional Opportunity Initiatives

GRADE 3-5 STEM CHALLENGE

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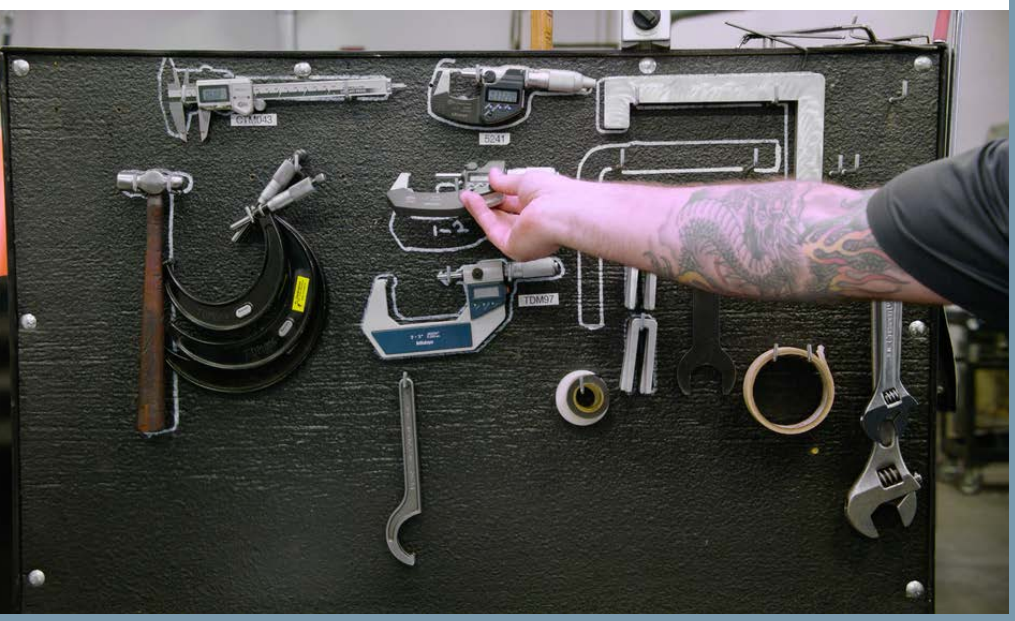
Inspired by Cory, a CNC Machinist in the Indiana Uplands.

Students will simulate writing and running a computer "program" to guide others in creating an object.



LESSON TIMELINE

DAY 1 60 Minutes

- Show the inspiration video, "Cory - Advanced CNC Operator"
- Students write their "computer program"

DAY 2 60 Minutes

- Test and Improve programs

DAY 3 60 Minutes

- Test the program: round 2
- Reflect and communicate

Recommended Supplies

For the class:

- Lego bricks or any other building bricks. Students will either need enough materials to build their figure 3 times (the original and 2 tests with classmates)

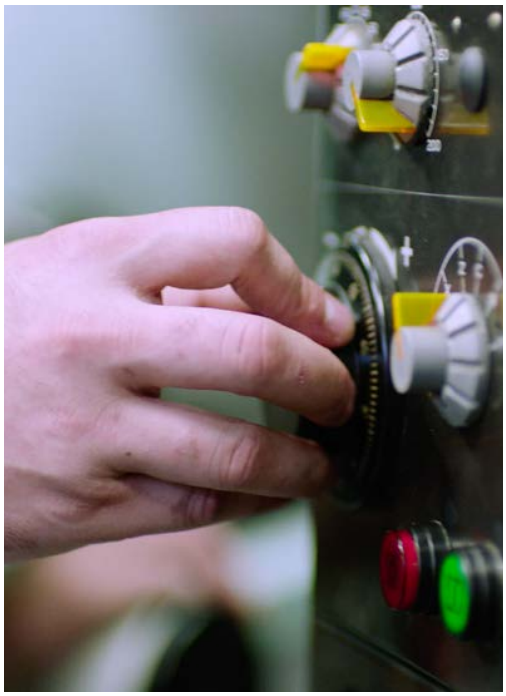
  OR

- Access to a device with a camera so that each figure can be documented, taken apart, and the parts reused.

CAREER CONNECTION AND LESSON OVERVIEW

Cory is an advanced CNC machinist at Jasper Engines and Transmissions in Jasper, Indiana. CNC stands for Computer Numerical Control and describes how the machines use coordinate programming and mapping to guide equipment like mills, routers, or lathes. Machinists like Cory use math and computer skills to program machines to create objects out of a block of metal, plastic, wood, or other material. What Cory loves most about his job is taking raw materials and turning them into something useful. To create new parts, CNC machinists have to take technical drawings and convert them into a series of instructions for the machines. He then programs the CNC machine to precisely carve the raw metal into parts for engines and transmissions.

In this activity, students will create a list of instructions, or a program, to direct their peers to build a figure out of Legos. Giving clear instructions is harder than it looks, and CNC machinists have to be extremely specific about the instructions they give to the CNC machines.



IN THIS CHALLENGE, STUDENTS WILL:

- Write a program (series of specific instructions) showing how to build a simple figure they design.
- Run the program by reading it to a partner as the partner builds the figure.
- Evaluate the product and the program for improvements
- Improve the program and test it again.

Standards

Science & Engineering Process Standards
SEPS.3 Constructing and performing investigations
SEPS.4 Analyzing and interpreting data
SEPS.5 Using mathematics and computational thinking
SEPS.7 Engaging in argument from evidence
SEPS.8 Obtaining, evaluating, and communicating information

English/Language Arts
3.SL.4.1 Using appropriate language, report on a topic or text, or provide a narrative that organizes ideas chronologically or around major points of information, with appropriate facts and relevant, descriptive details, speaking at an understandable pace, in a clear, concise manner.
4.SL.4.1 Using appropriate language, report on a topic or text, or provide a narrative in an organized manner, with effective introductions and conclusions, using appropriate structure, appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly and concisely at an understandable pace.
5.SL.4.1 Using appropriate language, present information on a topic or text, narrative, or opinion in an organized manner, with effective introductions and conclusions, using appropriate structure, appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly and concisely at an understandable pace.

Computer Science Standards
3-5.DI.2 Develop a simple understanding of an algorithm using computer-free exercises.
3-5.DI.5 Understand the connection between computer science and other fields.

Employability Skills Standards
3-5.M.2 Begin to discuss with peers about feedback received.
3-5.WE.4 Complete tasks or activities with prompting and guidance from adult educators.
3-5.WE.5 Demonstrate perseverance to complete tasks and activities.
3-5.LS.2 Communicate with others by applying a variety of speaking skills.
3-5.LS.3 Communicate with others using a variety of technology.
3-5.LS.4 Relate personal interests, abilities, and leisure time activities to possible occupational choices without stereotyping.
3-5.LS.8 Develop criteria for making decisions and predict results of choices to find the best solution.
3-5.LS.10 Identify a short-term goal and develop a plan of action.
3-5.LS.13 Utilize effective questioning and brainstorming techniques.

Planning and Implementation

MACHINING WITH FRIENDS

Essential Vocabulary

- ALGORITHM: A step by step list of instructions or process to complete a task.
- BUG: An error in a software program.
- ADVANCED MANUFACTURING: Using advanced technology to make things. People with careers in advanced manufacturing use their skills in computer programming and robotics to create products safely and efficiently.
- CNC: Computer numerical control, a way of controlling machines through code.
- COMPUTER PROGRAM: A collection of instructions that perform a specific task when carried out by a computer.
- PROGRAMMER: A person who writes computer programs.
- QUALITY ASSURANCE SUPERVISOR: A person who works to ensure that products are made the way they should be.

In this challenge, students will:

- View the job shadow video Cory-Advanced CNC Machinist available at http://regionalopportunityinc.org/cory
- Write a program (series of specific instructions) to build a simple figure they design
- 'Run the program' by reading it to direct their partner to build the figure
- Evaluate the product and the program for improvements
- Improve the program and test it again

Before Class:

- Read the lesson plan to become familiar with the activity.
- Gather necessary materials. Be sure that you have enough Legos for the students' designs or a way for them to record the items they build.

Day 1:

Introduction (20 Minutes)

Introduce the career of CNC machinist in the field of advanced manufacturing to the students. Advanced manufacturing is using high tech tools, like robots or computers, to make things. People with careers in advanced manufacturing use their skills in computer programming and robotics to create products safely and efficiently.

A Computer Numerical Control (CNC) machinist uses a computer to write a program. The computer, which is attached to a piece of machinery, follows the program to make something out of a raw material (like metal or wood.) Cory uses CNC machining to make parts for car engines.

Show Cory's career video and share his career profile with students. Point out to students that the box Cory works with in the video is the CNC machine. His Career Profile page may be projected and read together or you may want to provide individual printed copies to each student. Prompt students to reflect on the video and Career Profile sheet by asking students what they think is interesting about Cory's job and address any questions they may have.

Introduce the Challenge

Explain that students will use the engineering design process to write a series of directions similar to how a CNC machinist or computer programmer would write a computer program. The goal of the directions (computer program) will be for another pair of students to build a figure identical to one built by the original student team. After testing, students will have a chance to improve their program and 'run' it again.

Imagine (20 Minutes)

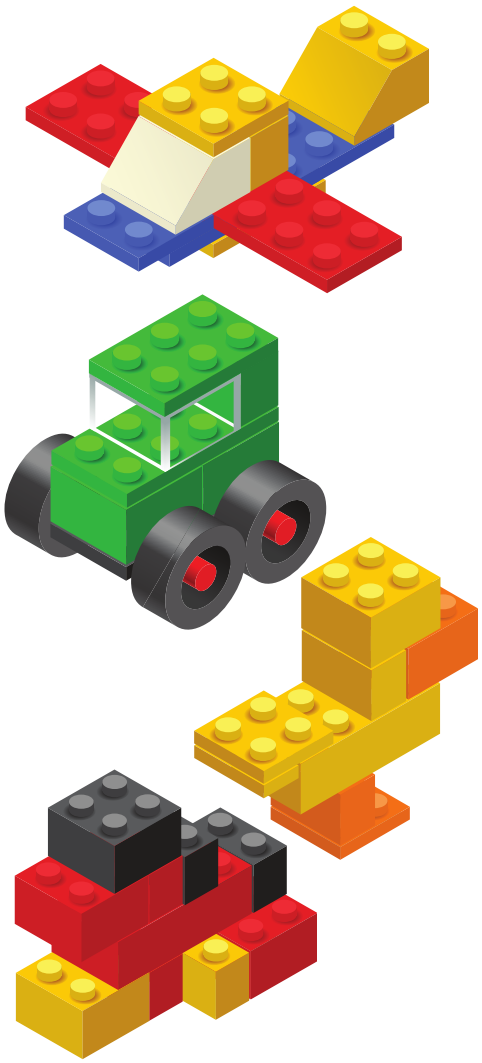
Students will work in pairs for this activity. Students will start by using the Engineering Design Process Sheet student handout. In the IMAGINE section, they will draw a few ideas of small figures that they could build for the challenge. Prompt students to consider the complexity of their figure and to begin thinking how they will give written directions on how to build it.

After generating a few ideas together, students should choose one idea and build the figure that they will work with for the remainder of this challenge. Remind students to keep their figure hidden from other class groups so they can't see what their figures look like! They want the person building their object to rely on the instructions the designer has written.

Plan (20 Minutes)

Students will now write their computer "program" to instruct a classmate on how to build a figure identical to the one that they have designed. Remind students that this is similar to what Cory does when he enters a program into the computer on the machine. Once the program is complete, he runs the machine and it follows his instructions to make a product. The benefit of using a program on a CNC machine is that the product the machine produces will be the same every time the program is run. This is an efficient way to make products for companies in advanced manufacturing.

As students begin writing their programs, prompt them to be specific about what should be done and in what order to avoid confusion when running the program. They may want to try the program themselves along the way to test how it works.



Day 2

Create and Test (30 Minutes)

As students finish their programs, each pair will need to:

- Collect the Lego pieces (or other building materials) needed to construct their figure.
  If pieces are limited, students can take a picture of their figure, take the figure apart, and reuse those pieces.
- Identify a Programmer and a Quality Assurance Supervisor.
  - The Programmer will read the program instructions one at a time sitting either behind a divider or with his or her back to the group who will be building.
    This is not illustrative of a CNC machinist not being able to see the program being run by the machine, but rather to reduce student temptation to veer from their written directions!
  - The Quality Assurance Supervisor will sit facing the group doing the building. During the building this student will silently observe, taking notes about which steps are confusing and can be improved upon.

When each pair is prepared with their assigned role and building materials ready, they should find another student pair to work with and trade instructions. Students should decide which group will read their program first (group #1). The group that will program second (and build first) is group #2.

- Group #2 should have a work area where they can spread out the building materials and build on a solid surface. Group #1 should sit according to the role they have (Programmer or Quality Assurance Supervisor).
- The programmer from group #1 will read the program instructions 1 by 1. After hearing each instruction, group #2 will use the building materials to carry out that instruction. Repeat this step until all instructions have been read.

It is important that the Programmer reads ONLY what is written in the program and that the Quality Assurance Supervisor remains silent and takes notes to inform future improvements. When the program instructions have all been read and the figure is complete, group 1 will collect the figure to use for reflection and improvement.

The groups will then switch places and repeat the procedure again, with group #1 building an object based on group #2's instructions.

Improve (30 Minutes)

Once both groups have had the chance to run their program, students should fill out the CREATE box on the Engineering Design Process student handout. Each pair will now make any needed adjustments to their program so that they can run it again.

Students will need to gather another set of building materials or take a picture of the figure produced previously, take it apart and reuse those materials.

Test: Round 2 (30 Minutes)

Once each student pair is prepared with their revised program and building materials, they will reconnect with the same student pair from the previous test and complete the testing cycle again. This time the Programmer and Quality Assurance Supervisor will switch roles.

- Group #2 should sit at a space where they can spread out the building materials and build on a solid surface. Group #1 should sit according to the role they have.
- The new programmer from group #1 will read the program instructions 1 by 1. After hearing each instruction, group #2 will use the building materials to carry out that instruction. Repeat this step until all instructions have been read.

Again: it is important that the Programmer read only what is written in the program and that the Quality Assurance Supervisor remains silent and takes notes to inform future improvements. When the program instructions have all been read and the figure is complete, group 1 will collect the figure to use for reflection and improvement.

The groups will now switch places and repeat the procedure again. Once all testing is complete, each group can share their original figure with the other group and reflect on what made this task challenging.

Discuss and Report

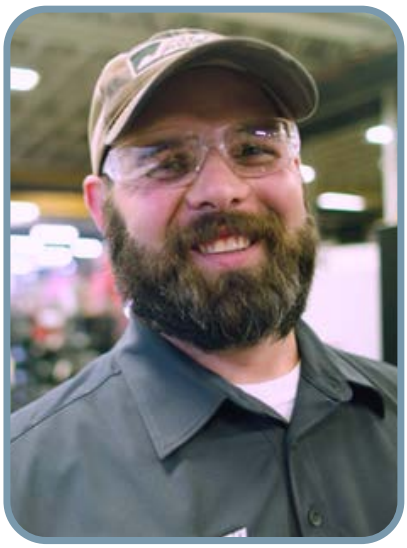
Communicate (30 Minutes)

Students will fill out the IMPROVE and COMMUNICATE sections of the Engineering Design Process Student Handout.

Students will share their original figure, the figure from test #1 and the figure from test #2 along with their reflection from the IMPROVE and COMMUNICATE sections of the Engineering Design Process student handout. Students may share out their process and findings with another pair of classmates or with the class as a whole.

If time allows, students could prepare a digital presentation of the material as well.

Career Exploration and Extension



Prompt students to think about and research what a career as a CNC machinist might entail.

- What does a CNC Machinist do all day? What does Cory do?
- What kind of school would a student need to become a CNC machinist? What other types of related jobs are there? Where are these jobs found?
- Are jobs like Cory's in high demand? Why are jobs like this important?

Name: _____

Machining with Friends

Engineering Design Process Sheet

ASK

What is the problem we are going to solve?

Build a simple figure out of blocks or Legos and write a 'program' so that any person who follows the program can build a figure identical to yours.

IMAGINE

Brainstorm solutions to the problem above.
Record your ideas in words or pictures.

Name: _____

PLAN

Write out a list of instructions (a program) that will tell someone else how to build your figure.

CREATE

You will have _____minutes.
Use this time to read your program to a classmate so they can build.

Describe the figure that your classmate created from your program.

Is it like the original? If not, how is it different from your original?

Name: _____

IMPROVE

Edit the program to make it more clear.

Explain the changes that your group made to the program.

Did the changes produce a figure that looked more like the original figure than the first program?

COMMUNICATE

Share your programs and products with the class or another group.

What was the most difficult part of this challenge?

What was the most successful part of this challenge for your group?

ACKNOWLEDGEMENTS

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IMAGE AND CONTENT CREDITS

Images

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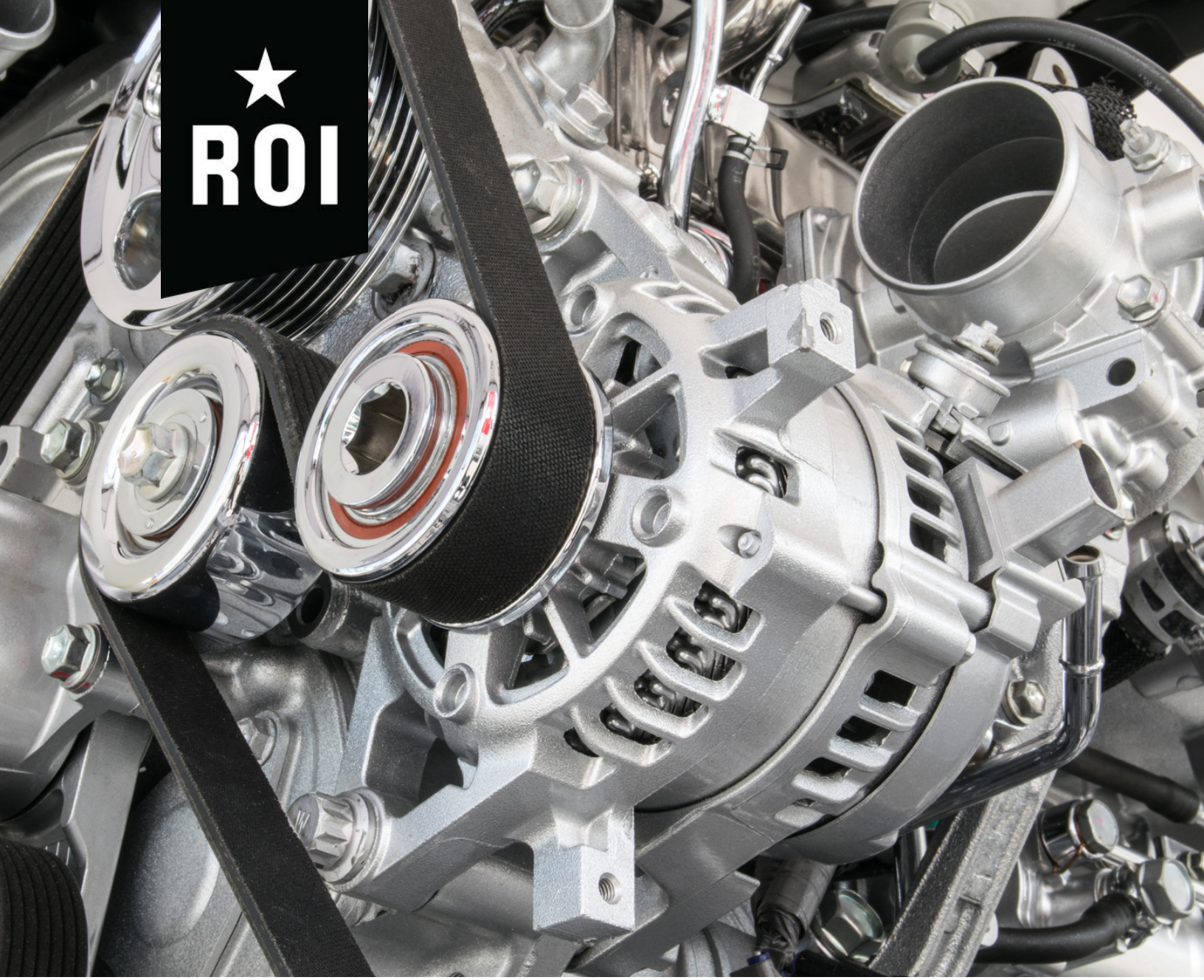
Content

Lesson adapted from 6 Unplugged Coding Activities for Hour of Code. (2020, February 12). Retrieved from http://info.thinkfun.com/stem-education/6-unplugged-coding-activities-for-hour-of-code.



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