Lego Spike CNC

MaFEA – Making Future Education Accessible
PR3 - EDUCATIONAL LEARNING PATHS

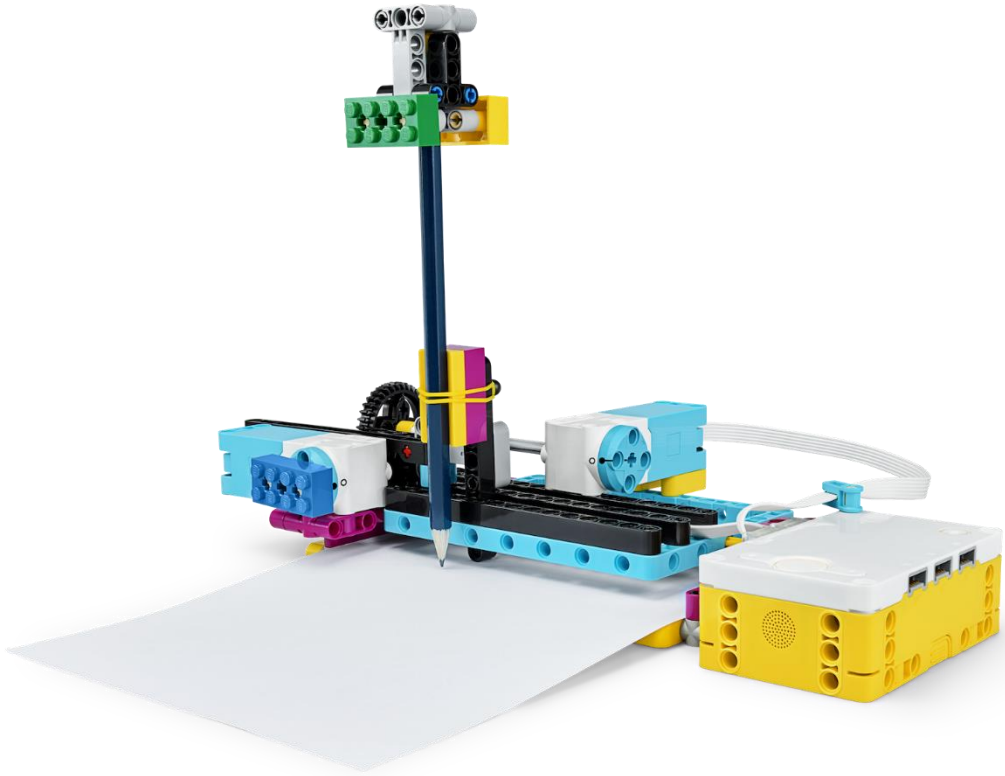
Technology tools:	Hardware: Lego Spike Prime Software: Lego Spike download or Lego Spike online use
Tool version:	
	No optional tools
Date:	9-13 /05/2023
College:	Emmaüs secundair Aalter, Belgium
Author (optional):	
Subject of the lesson(s):	Designing and upgrading a machine while programming with word blocks
Target group	13-14 years of age

Funded by the European Union

Lesson title/subject: CNC- Machine / designing, upgrading, programming

Intention: What do you wish for or hope to happen? (Intentions are often not measurable or tangible, but help you in developing the design process.)
1. The aim of the lesson is for students to evaluate and improve a basic design of a CNC machine, Bottom and Top. 2. With every adjustment to the basic design, the software has to be modified accordingly. 3. The students already have knowledge of programming with word blocks
Desired Outcomes: One or more measurable and tangible goals the teacher aims for with this lesson/these lessons.
1. The students make a program to print letters with the basic machine. Extra challenge: the students print letters with combined movements. 2. The students improve the design of the basic machine. (engineering) 3. The students build in a third motor and print the letters separately. (engineering + programming) 4. Peer-evaluation: At the end they have to assess each other's work, effort and involvement.
Agenda: HOW are you going to reach the goals? Description of the lesson plan / educational activities / working methods.
1. The students already have knowledge of programming with word blocks. 2. The first part of the lesson is an explanation of the assignment and some background information. 3. For the next step the students work in small groups to complete the assignment.
Roles: Who facilitates what? Who participates? What do we expect of the students?
1. The students work in groups of 2 or 3. They divide the work within the group. There are 3 roles. You have the engineer, the programmer and the administrator. 2. As a teacher, you will support the engineering at the request of the students. Some groups can work completely independent, others need a little push.
Rules: Rules or principles are about how you want to learn and work together.
1. The students can already program with word blocks 2. The students know the basics of Lego Spike Prime 3. The students know in advance how they will be evaluated.
Time: Describe the time path: What time do we start / finish / break? When is the time for reflection? What happens between contact times?
1. You need 2 lessons of 100 minutes for this project. The intro and the basic machine take up about 40min. From that point on it depends on how quickly the students find a solution to their problem. Trial and Error. 2. At the end, 15 minutes are provided to dismantle the machine and sort the box. In this way, the next group can start smoothly.

Emmaüs Aalter
secundaire school OP WEG



CNC-machine

Lego Spike

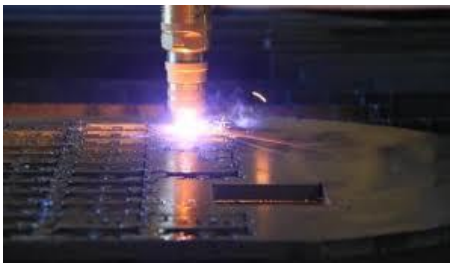
1. Problem

The printer is broken and we urgently need to print a document. Build a printer using the SPIKE and print your initials!

2. Design/Research

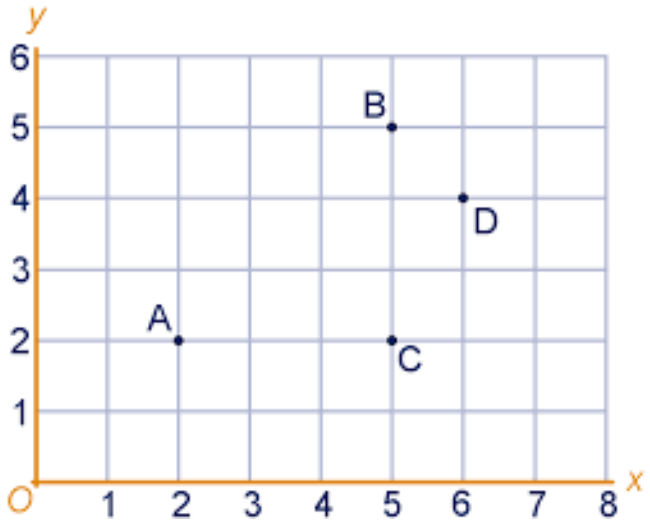
2.1 What is a printer?

A printer is actually a CNC machine. This is a computer-controlled machine used to manipulate or process materials. To do this, you first create a 2D or 3D drawing (LibreCad, RdWorks, Autocad, Tinkercad...) that the machine (plasma cutter, laser cutter, 3D printer...) can work with.

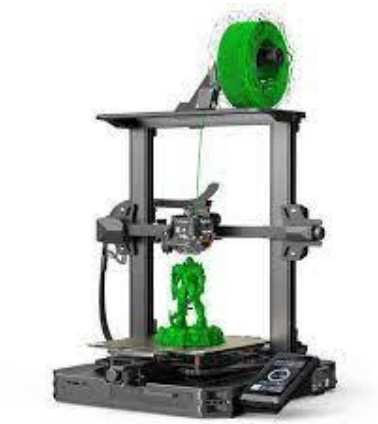


The machine uses coordinates from the drawing program to perform the correct operation. You already know this system from math class where you use the X and Y axis for a 2D representation. For a 3D representation, this is the X, Y, and Z axis.

Task: Fill in the coordinates in the table using the graph:



A	(,)
B	(,)
C	(,)
D	(,)



You can divide the CNC machines into 2 groups:

Group 1: The cutting machines

Within this group, the machine will manipulate the material in such a way that it removes/cuts away pieces of this material. This can be done in various ways.

Spiral drill	**Surfacing router cutter**	**Router cutter**	**Sheet cutting**
			
When drilling, you only go straight down. After all, you want to make a nice straight hole. So, one axis.	Here, the machine will move the router cutter in the 3 axes: 1st up and down 2nd left and right 3rd front and back. This is all combined.	Here, the machine will move the milling cutter in the 3 axes: 1st up and down 2nd left and right 3rd front and back. This is all combined.	Water, sand or a laser beam is useda to cut through the material.

Group 2: The non-cutting machines

Within this group, the machine will add material to the material to be processed. A well-known example of this is the regular printer where 2 motors control the x and y axis to get the ink in the right place. The 3D printer is also applicable here.

Which group does our printer belong to?

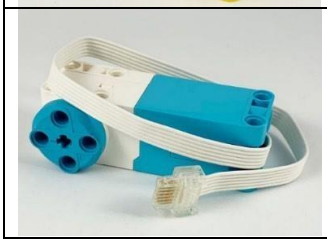
Cutting machine / Non-cutting machine

3. Make

3.1 Building the hardware

Go to the "Lego Spike education" app, choose "build", select "CNC machine" and follow the building instructions.

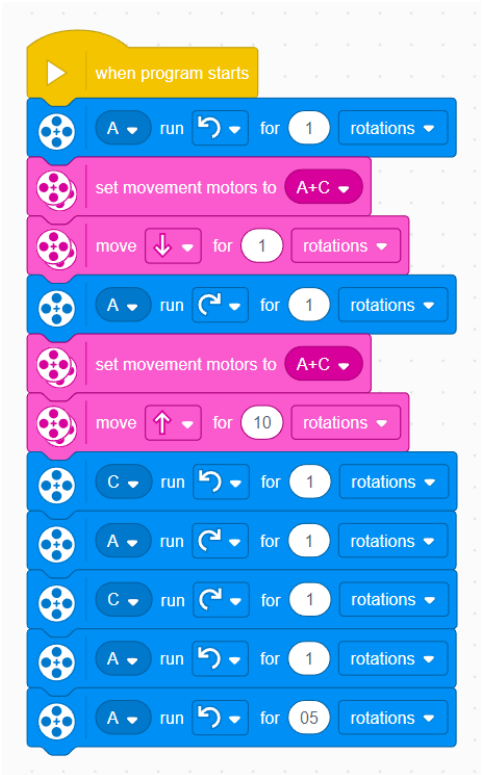
When building this CNC machine, you will use the following major parts, but what do they do?

	**Programmable HUB** This is the computer of the system. It has 6 ports (A, B, C, D, E and F). These ports can be used as both input and output. The hub has a 6-axis gyro sensor built in to determine the position of the hub.
	**Small motor** This allows you to move parts or your entire machine. There is a zero position provided. The position can vary between 0° and 359°. You can measure the position and speed of this motor. This motor has less power than the large motor.

3.2 Programming the software

Go to the "Lego Spike education" app, choose "Start", select the various tutorials to learn the basic instructions.

By means of motor controls and movements, you can move the printer. Make sure that you write the initials "MG" with your CNC machine. You can see this depicted in the example shown on the right.



Note:

- Check if your motors are set up through the correct port.
- The settings are not yet correct or complete. You will have to adjust and test this yourself to get a good print.

4. Testing

Test your program until you get a good print.

5. Evaluate

Did the programming go smoothly? If not, where did it get difficult?:

_____

_____

Is the construction of the printer sturdy and solid?

If not, what is not sturdy or solid?

_____

_____

If not, does this cause printing problems?

_____

_____

6. Expansion 1

6.1 Problem

Your evaluation should show that your CNC machine is not sturdy enough to print smoothly, or that improvements can be made.

6.2 Design/Research

What can be improved on your CNC machine?

_____

_____

_____

Upgrade your CNC machine to a sturdier version. Write down or sketch your ideas below.

6.3 Make

Implement your modification.

6.4 Testing

Test your modification.

6.5 Evaluate

Were your modifications successful? If not, go back to step 6.2 to make changes to your design.

7. Expansion 2

7.1 Problem

So far, our CNC machine can only move on the X and Y axes. When inserting paper or leaving space between the letters, you still have to do this manually.

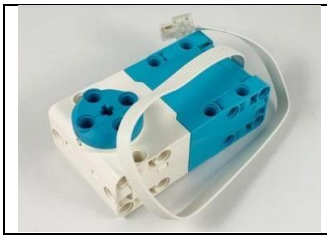
7.2 Design/Research

How can you solve the problem?

_____

_____

One possibility is to make the bridge move with the extra motor. You can do this with the large motor.

	**Large motor** This allows you to move parts or your entire machine. There is a zero position provided. The position can vary between 0° and 359°. You can measure the position and speed of this motor.

Upgrade your CNC machine to enable this application. Write down or sketch your ideas below.

7.3 Make

Implement your modification.

7.4 Testing

Test your modification

7.5 Evaluate

Were your modifications successful?

If not, where do you think it went wrong?

_____

_____

Go back to step 7.2 to make changes to your design.

Peer evaluation

Enter the name of your group member and highlight what fits

Name				
Effort	Gave up very quickly when things didn't work.	Gave up quickly when things didn't work but regained momentum after feedback.	Gave up sometimes but took the initiative to take on the task again.	Kept persevering and looking for a solution.
Engagement	Was not at all involved in group work.	Was often not involved in group work.	Was sometimes not involved in group work.	Was always involved in group work.

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