

# LEGO® Sorting Robot for the Classroom

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## Objective

- Design an automated system to sort a classroom set of LEGO® Mindstorms robotics kits (shown on the right), a popular K-12 education tool used in classes, summer camps, and extracurricular programs around the world.
- By automating a repetitive and tedious task, this robot aims to reduce labor costs and increase time available for STEM instruction.



LEGO® Mindstorms Education kit. Each kit comes with a sorting tray with designated part locations.

## Consumer Research

According to interviews conducted with LEGO® Mindstorms educators, this robot should:

- Sort multiple kits simultaneously
- Optimize usage, setup, and storage
- Minimize user intervention
- Sort a classroom set of kits (15) overnight
- Cost between \$500 - \$700

## Design

### (1) Hopper

Bin that holds unsorted LEGO® parts



### (2) Serializer

6 conveyor belts increasing in velocity to separate a pile of incoming parts into a single stream



### (3) Identifier

Camera & convolutional neural network that identifies color and part number of each part



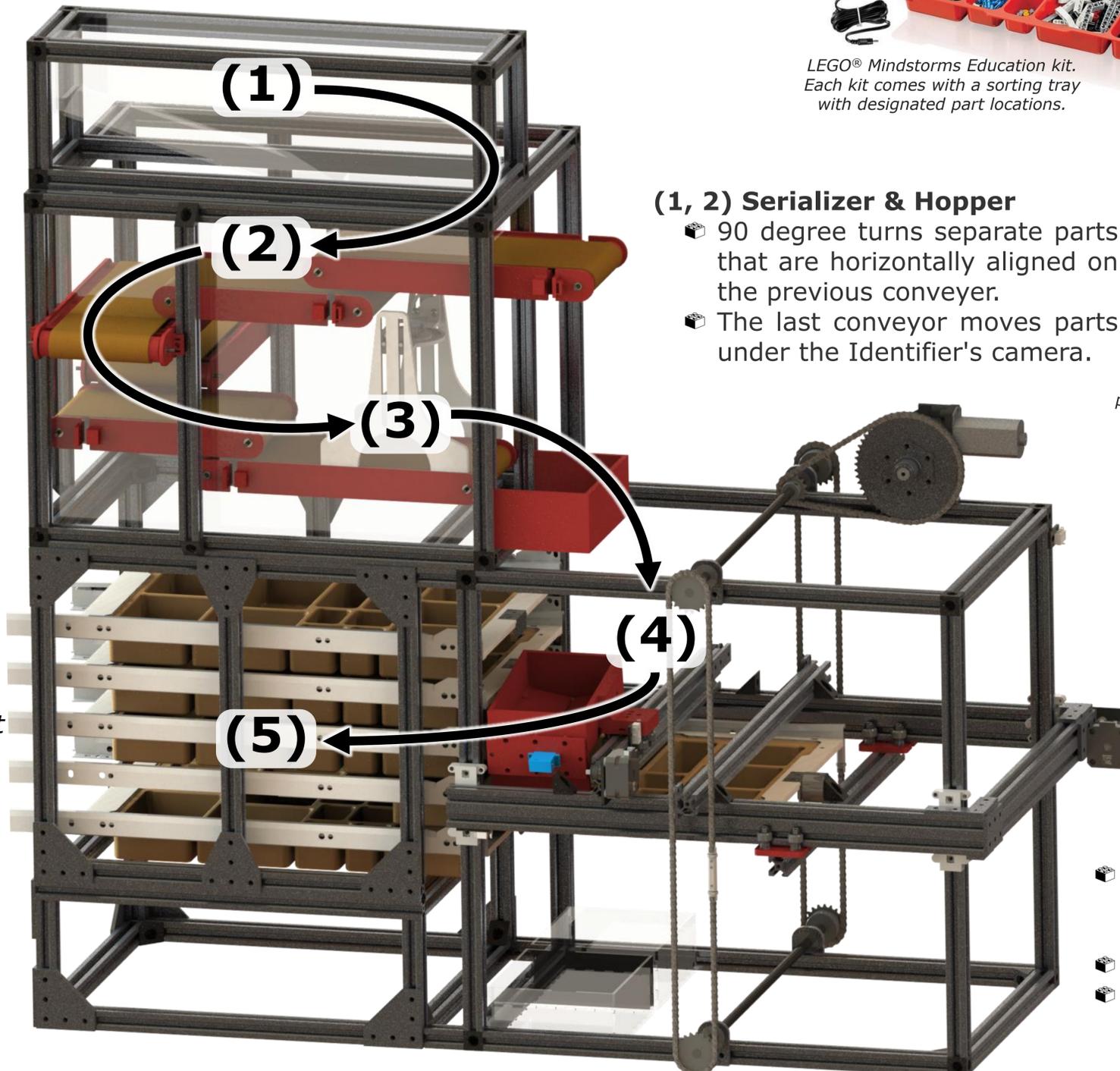
### (4) Distributor

3-axis Cartesian robot that places an identified part into the correct sorting tray pocket



### (5) Storage Tower

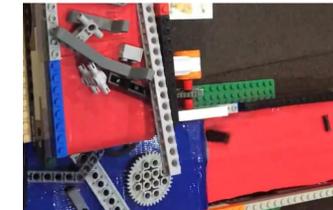
Set of drawers holding the sorting trays provided in LEGO® Education kits



### (1, 2) Serializer & Hopper

- 90 degree turns separate parts that are horizontally aligned on the previous conveyer.
- The last conveyer moves parts under the Identifier's camera.

## Methodology



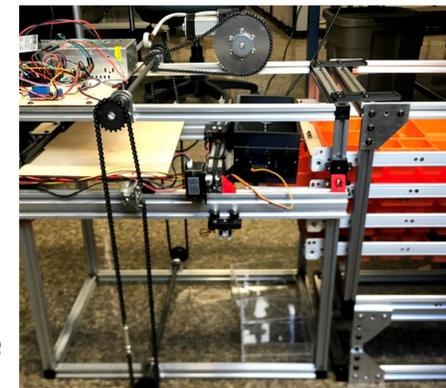
Serializer prototype demonstrates parts entering clustered together and exiting in a spaced-out stream

### (3) Identifier

- Convolutional neural network trained using domain randomization of existing LEGO® part models.
- NVIDIA Jetson Nano 2GB used as robot microprocessor for integrated identifying.

### (4, 5) Distributor & Storage Tower

- Vertically stacked trays minimize floor space needed, allow for customizable kit capacity (by changing storage tower height), and keep travel times consistent throughout the duration of the sort.
- Drawers manipulated using an electromagnet mounted to the "y-axis".



Distributor Prototype

## Results

- Designed an affordable and useful robotic system for LEGO® Mindstorms educators to reduce time wasted sorting parts and improve teaching workflow.
- Tested subsystems individually.
- Future work should focus on system integration, improving part recognition software, and moving from prototypes to a product ready for distribution to consumers.