Robotics: Engineering a Rocket Transporter

Identify the problem

How would you transport an 18-million-pound rocket and mobile launch pad three miles and deliver it upright for launch? What kind of grapple, end effector or robotic hand would be best suited for holding and moving such a massive object?

For this challenge, you will need to build a robot to simulate this rocket transportation technique.

Criteria for Success

For this challenge, you must:

- Equip your robot crawler to transport a payload.
- Program your robot crawler to transport the payload to a launch pad 91.5 cm (about 3 feet) away.
- Deliver the payload upright on the target launch pad.
- Return the robot crawler to the starting point.

Engineering Constraints

- Once you run the program, you must not touch or apply any outside force to the robot or the payload.
- Only programmable motors can be used for arm controls, no sensors.
- The challenge relies solely on wheel rotations for distance and power management for speed. No other sensors may be employed in the challenge.

Points for this challenge will be as follows:

Carry the payload from the starting position to the target without loss	10 points
Deliver the payload in an upright position	20 points
Return the super crawler to the starting position	10 points
Payload not delivered upright for launch	-2 points
Loss of payload	-2 points (each instance)
Touch the payload or super crawler outside of the start position	-2 points (each instance)

Brainstorm possible solutions

Study photos of NASA's super crawlers, various robotic end effectors and their features. Consider features that might be useful in designing your solution to fit the criteria and constraints of the challenge. Every team member should draw upon their own background, prior knowledge, experience and strengths to contribute throughout the engineering design process.

Select a design

Use the material available to construct your robotic arm and end effector. You should also consider the programming specs required to move your rocket 91.5 cm (about 3 feet) from the super crawler to the launch pad, while delivering the payload in an upright position. Draw sketches of your design and label the parts with expected functions. Also include any equations or ratio reasoning to support the programming you plan to use with your design.

Build a prototype or model

Build your prototype for the super crawler's arm and end effector from your design sketch. Once the construction and programming for the super crawler are complete, begin testing.

Test the model and evaluate

Troubleshoot problems as they occur. If the super crawler isn't traveling the correct distance, perhaps recalculate the number of rotations needed or check your programming. If the prototype loses the payload or is unable to deliver it in an upright position, assess why the arm failed and determine what changes you might make.

Improve the design

Record any changes to your design, such as in a journal or on a blank sheet of paper, and be sure to include why you decided to make the changes. When your super crawler model is ready for the official challenge, prepare to complete the challenge for an official score.

Share the solution

Present your solutions to the class using photo or video evidence with supporting sketches and justifications for your design. Incorporate data charts or graphics where appropriate. You may use audio-visual equipment and technologies to enhance your presentation. Be sure to express how teamwork and the engineering design process played a role in your group's experience with this challenge. Use the reflection questions below to guide your presentation development.

Reflection Questions

About the engineering design process:

- What did you try that didn't work out? How many times did you try it?
- What did you do when things didn't work out like you expected?
- If given access to more parts or sensors, how would it change your design?
- If given more time, what would your next step look like?

About your thinking during the challenge:

- What obstacles did you or your group face in this challenge?
- How did you and/or your group confront these obstacles?
- What was your favorite part of designing, building and testing your robot?
- Did you observe any benefit to blueprinting your design first? Did you need to make any revisions to your blueprint after your first series of tests?