

MAKEngineering Kit
Facilitation Guide:
Indoor Game: Soccer
Bot



ENGINEERING TASK

You have been asked by a popular game company to develop handheld soccer bots for a new indoor game for two players. A soccer bot is a robot that plays soccer. For this game, players score goals by hitting a small ball into the opposing "net". (Psst. You are Player 1. Who is Player 2?) Check out this video to see the game being played:
<https://youtu.be/9NViVG80CHI>

DID YOU KNOW...?

Engineers play an important role in sports, specifically in the design of equipment (e.g., badminton rackets, shin guards, baseball bats) and attire (e.g., swimsuits, socks). Here is a video to learn more

<https://youtu.be/r3FUMwA1ahY?t=105>

The next time you play your favorite sport, think about how an engineer might have been involved in designing the equipment you are using!

MATERIALS IN KIT

Each player will have the following:

- 1 Motor
- 1 AA battery
- 1 Battery holder
- 1 Push button switch
- 1 Sheet of cardstock
- 10 Popsicle sticks
- 5 Rubber bands
- 2 Binder clips

Two players will share:

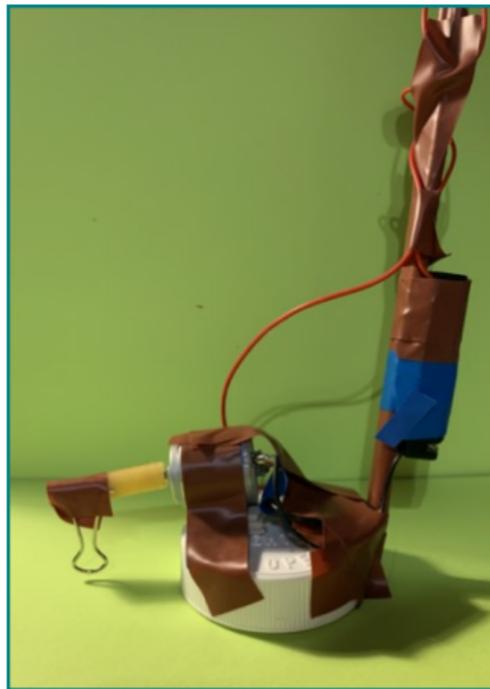
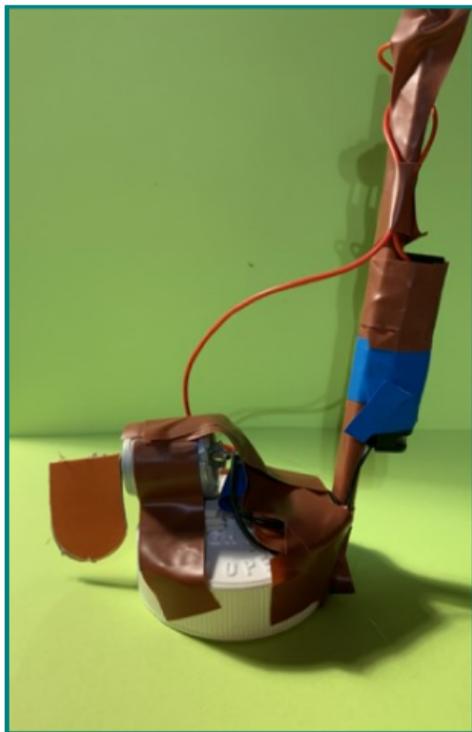
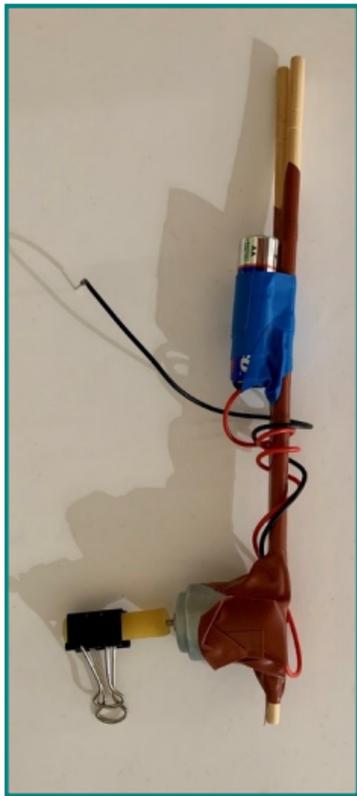
- Electrical tape
- 1 Ping Pong ball
- Hot glue gun
- 2 Hot glue sticks

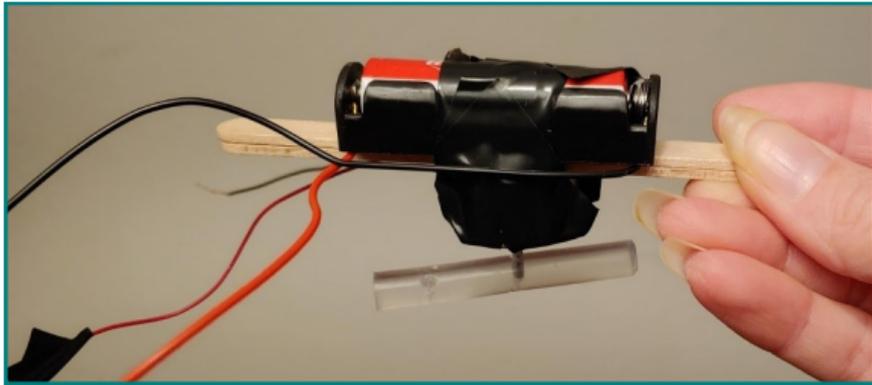


STEP 1—RESEARCH

What comes to mind when you hear “research”? As an engineer, sometimes research includes examining products that already exist. On the following pages, we have included images of soccer bots for you to “research.” It is also okay for you to ask someone to take notes on what you notice.

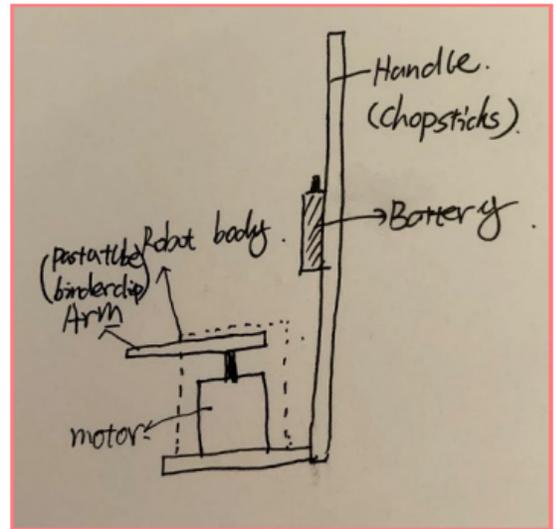
- * What are the key characteristics of the soccer bots?
- * What materials are used? How are the material used?
- * How do you think the soccer bot works?
- * Where might the soccer bot player place their hand?





STEP 2—PLAN

Sketch 2-3 different designs of soccer bots and make a list of material for each design. How are your designs based on your research? What new characteristics did you include in your designs?



7-A

STEP 2—SUPPORT

Potential questions to pose:

- Who do you imagine are the users of the game?
How might that impact the plans?
- What are items we might use for the arm of the bot? It does not have to be items in the kit.
- How might the placement of the arm on the motor impact how the bot kicks the ball?
- Tell me more about _____.

STEP 3—EXPLORE

Let's explore! Use what you learned from the previous low-tech kit to test your motor.

- * Explain how to connect the battery pack to the motor. How would you explain this someone six-years old?
- * What kind of motion does the motor create? How can you use this motion to kick a ball?
- * Now let's think about the button switch. What do you think is the purpose of the switch? How might you include the switch into your simple circuit?

STEP 3—SUPPORT

We have provided a video to illustrate how to construct a simple circuit using the battery pack, motor, and push button switch.

<https://youtu.be/VPWT7hbP1jw>

Use the video to guide the exploration and soccer bot designs. Here are a few potential questions to pose:

- How do you know the motor is working?
- The button switch has four pins for mechanical stability. How can we determine which two pins to use?

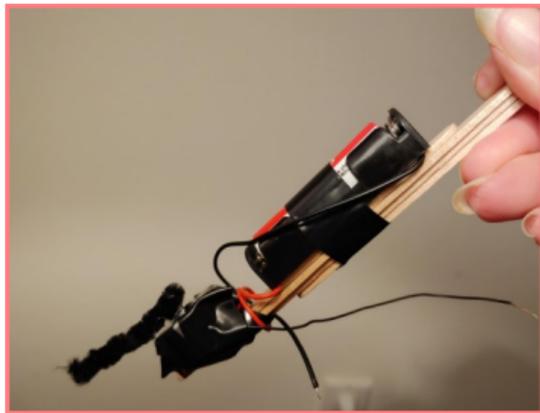


COMMUNICATION

Have a conversation about the research steps of the engineering task. The camera can be focused on the plans.

1. What is one thing you have learned so far?
2. Which sketch is the most unique? Explain.
3. Will you make any changes to your design based on your exploration of the electronic parts? Explain.
4. What do you foresee as challenges in the creation of the soccer bots? Why?

STEP 4—CREATE



Pick one of your designs from Step 2 and build the soccer bot.

You can only use materials in the kit or anything around your home. This video shows how to connect arms to the motor—

<https://youtu.be/yjnzAJgES2M>.

How is your prototype different from Player 2?

STEP 5—PREPARE THE SOCCER FIELD

Use electrical tape to mark the position of the midfield and place the two nets at the end. How far apart will you make the two nets? How did you make this decision? How will prevent the ball from flying across the room?



10-A

STEP 5—SUPPORT

Potential questions to ask for Page 10-A and Page 11.

- Standard soccer fields must be between 100-130 yards in length and 50-100 yards in width. The center circle has a radius (straight line from center to any point on the circle) of 10 yards. How might we use this information in our soccer field?
- What material do we have to create a net?
- What is a reasonable size for the net? How is your decision based on the diameter of the ping pong?
- How will the size of the net impact the game?

10-B

STEP 5—PREPARE THE SOCCER FIELD

Design a net for the bot to “kick” a ping pong ball through. How big should the net be?



BE CREATIVE!

STEP 6—TEST & IMPROVE (EACH PLAYER)

Use your soccer bot to kick a ping pong ball from one net to the other (see https://youtu.be/d4ab_09rljs for an example).

- * Is your bot able to kick the ball into the opposite net? Why or why not?
- * Did the ball roll straight? Does that matter? Explain.
- * What changes may be needed? Why?

Make any changes and continue to test your bot until you are satisfied with how the bot kicks the ball.

SOCCER BOT GAME RULES

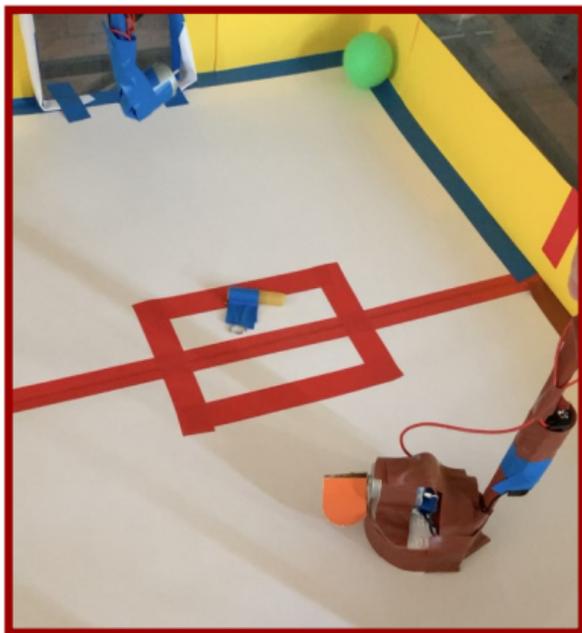
Watch this video for the first two rules
<https://youtu.be/9S23TBfa9j0>

1. Only the bots' "arms" can touch the ball.
2. Players can hold and pass the ball, but not swing the bot to hit the ball.
3. Players score goals by hitting a ball into the opposing net with the handheld soccer bot.
4. Game play starts with the ball at the midfield.
5. The first play to score 5 goals wins.

SOCCER BOT ADDITIONAL GAME RULES

These additional rules might need to be negotiated during game time.

- Can bots position themselves so that they block the goal?
- Are there constraints for how the bot can move across the field?
- Who goes first? Or do players vie for the ball?
- Does it count if the ball bounces off the goal post into the net?



STEP 7

**GAME
TIME!**



COMMUNICATION

Imagine you are a player being interviewed by a sportscaster, answer the following questions. The camera can be focused on the soccer field.

1. Describe the turning point or big play of the game.
2. What strategies did you use to play the game?
3. How would you describe your opponent?
4. What did you learn from the game that you will use in future games?

STEP 8—REDESIGN

Is your bot able to kick the ball into the opposite net when another player is present? What improvements might be made? Why do you think this? Make any changes and test your bot again through playing the game. (Psst. The soccer bot can have multiple arms.)

STEP 9—GAME RULES

The game company would like for you to develop additional games that can be played with the handheld soccer bots. Develop at least one new game with different rules from the one you just played. Is this game fair? Be sure to test the game. Would you change the rules after playing the game? Explain.



STEP 9—SUPPORT

Potential questions to ask:

- Let's think about what you liked and disliked about the game we just played. What ideas and rules do you have for a new game?
- What do you know about the game of soccer that might help? We can also consider other sports like hockey or golf. (Conduct research if needed)
- Tell me more about this rule. Is it a fair or an unfair rule?
- I have a suggestion (e.g., place obstacles on the field). Can I share it with you?



COMMUNICATION

Develop a marketing plan to showcase the new game. Include the following in your marketing plan and then shoot a commercial. We suggest including the soccer field and/or soccer bots as part of the commercial.

1. What is the name of the new game?
2. Who are the users?
3. What are the rules of the new game?
4. What makes this game unique? Why should anyone want to purchase the game?
5. What did you learn from building your own soccer bot and playing the game that you would like to share with others?

DID YOU KNOW...?

Sports engineering is a newer engineering field. They are concerned with the research and development of technologies for the sports industry—equipment and environment. A common trait of sports engineers are their love for sports and passion for science and technology. Many sports engineers have a background as a mechanical or materials engineer. Sports engineers earn about \$53.98 per hour. How much do they earn in a year?

WHAT TYPE OF ENGINEER ARE YOU?

Add a sticker to your Engineering Passport that identifies the type of engineer you were most like in the design of a soccer bot. Don't forget to write why you chose the type of engineer.



This engineering kit would not have been possible without funding and support from the National Science Foundation.