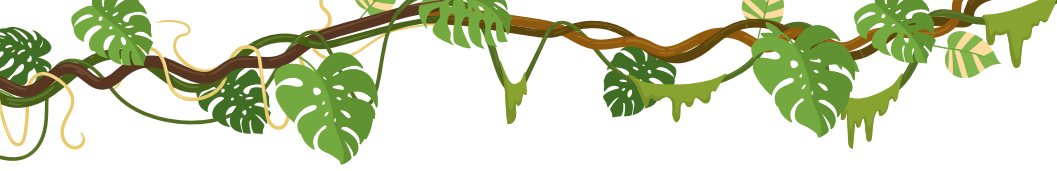


**FIRST[®]
LEGO[®]
LEAGUE**

CHALLENGE

ENGINEERING NOTEBOOK





FIRST[®] **LEGO**[®] League Global Sponsors

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Welcome!

Use the sessions in this *Engineering Notebook* as a guide for your team's journey through the *FIRST® CANOPY™* presented by Qualcomm season and BIOGLOW™ challenge. This guide will lead you and your team through 12 sessions to prepare for your competition.

Use the *FIRST Core Values* and the **Engineering Design Process** throughout your team journey. Have lots of fun as you develop new skills and work together! This notebook is a great resource to share at your judging event, but it isn't required. Check out careers related to the season theme at the end of this notebook.

FIRST® Core Values



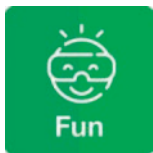
We are stronger when we work together.



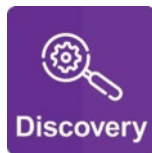
We respect each other and embrace our differences.



We apply what we learn to improve our world.



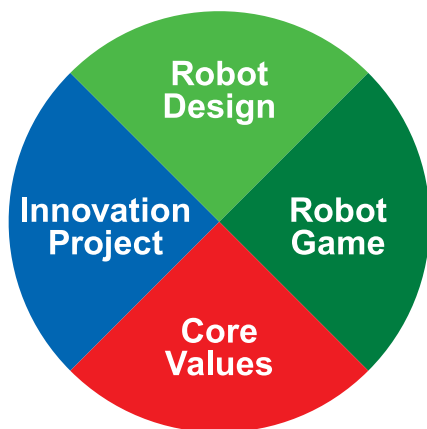
We enjoy and celebrate what we do!



We explore new skills and ideas.



We use creativity and persistence to solve problems.



At the event, your team will present your robot design and innovation project work to the judges during the judging session, and your robot performance will be evaluated at the robot game. Core Values are evaluated in all parts of your work, and you will receive scores from the judges and referees for how you apply them.

Each of the four equally weighted parts of *FIRST® LEGO® League Challenge* accounts for 25% of your total performance at your event.

We show our Core Values through *Gracious Professionalism®* and *Coopertition®*, and this will be evaluated during robot game matches.

Gracious Professionalism is a way of doing things that encourages high-quality work, emphasizes the value of others, and respects individuals and the community.

Coopertition means teams help and cooperate with each other, even as they compete.

Robot Design and Robot Game

Get ready to venture into the heart of the rainforest, where every mission helps protect biodiversity.

Your robot will complete missions that mimic real ecological processes like seed dispersal, fungal networks, canopy research, habitat protection, and species conservation.

Build and code a robot that will complete missions in the 2.5-minute robot game.

Identify: Determine which missions to attempt and explore building and coding resources.

- Build the mission models and decide which missions your team will attempt and in what order by creating a **clear mission strategy**.
- Explore available **building and coding resources** to support your plan.

Design: Work collaboratively on designs and develop building and coding skills.

- Identify the building and coding skills you need and learn them as a team. Make sure **every team member contributes ideas** for building, coding, and strategy.
- Document how your robot's design changes as you learn to work together and adapt your mission strategy.

Create: Develop original designs or improve existing ones.

- Explain the purpose of a design or any attachments. Build your robot and any attachments using LEGO® Education SPIKE™ Prime or compatible sets.
- Show how your code and attachments support your mission strategy.

Iterate: Test the robot and code to identify areas for improvement.

- Test your robot repeatedly on the game field. Record what works, what doesn't, and what you adjust. Judges will want to understand what changes have been made.
- Use evidence from testing to improve both code and design. Make changes to improve consistency, accuracy, and mission performance.

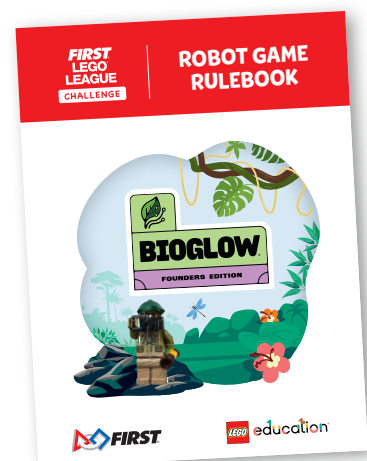
Communicate: Explain what you learned from the robot design process and celebrate your progress.

- You will have five minutes to share about your robot design process. Use the rubric as your guide.
- A clear mission strategy and evidence of improvement will help your team stand out.

The referees will score your robot performance in the game. The judges will assess your team's process in building and coding your robot.



Robot
Resources



Innovation Project

Biodiversity keeps our planet healthy. In the rainforest, from the tiniest insects to towering trees, there are countless plant and animal species depending on one another to survive.

This season, your challenge is to identify a problem that puts biodiversity at risk and design an innovative solution that can help.



Identify: Clearly define the problem and do research.

- Choose a problem related to the prompt that interests your team. Clearly define what the problem is and why it matters.
- Research the problem and solutions that already exist. Use **reliable sources** to understand what works, what doesn't, and what challenges remain.

Design: Work together to create a project plan and develop your ideas.

- Brainstorm possible ideas with your team. Could you create something new, adapt technology from another field, or improve an existing idea?
- Outline a **project plan** for how you will investigate, share, and refine your solution.

Create: Develop an original idea or build on an existing one with a prototype model/drawing.

- Clearly describe how your innovative solution addresses the problem you identified. What does it do? How does it impact biodiversity?
- Make a **prototype model** or **drawing** of your solution and plan to share it with others.

Iterate: Share your ideas with others, collect feedback, and make improvements to your solution.

- Share your ideas with other teams or mentors and gather feedback. Record what you learned and what you changed.
- Show **evidence of improvements** you made based on testing or feedback.

Communicate: Share an effective presentation of your solution, describe its impact on others, and celebrate your progress.

- Create a five-minute live presentation that describes your solution. Use the rubric as your guide.
- Highlight how your team uses **Core Values** and make sure **every team member participates**.

Tip

Be ready for the judges' questions. They want to understand your journey and progress.

Project Sparks

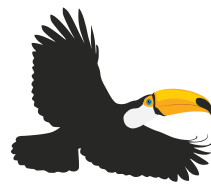
Use one of the Project Sparks or think of a different problem that interests your team.

To safely study rainforests, scientists and explorers use drones to reach places humans can't easily go, like dense canopies or flooding terrain.

How could you use aerial technology to help the rainforest?



Emergent Layer



Ecologists use simple tools to study how rainforest plants grow and support wildlife. People help protect the ecosystem and the communities that depend on it.

How could you use tools in an innovative way to support a local ecosystem?

Canopy Layer



Wildlife biologists use tools like camera traps and tracking devices to study rainforest animals and their habitats.

How could you use tools in an innovative way to support a local ecosystem?



Understory Layer



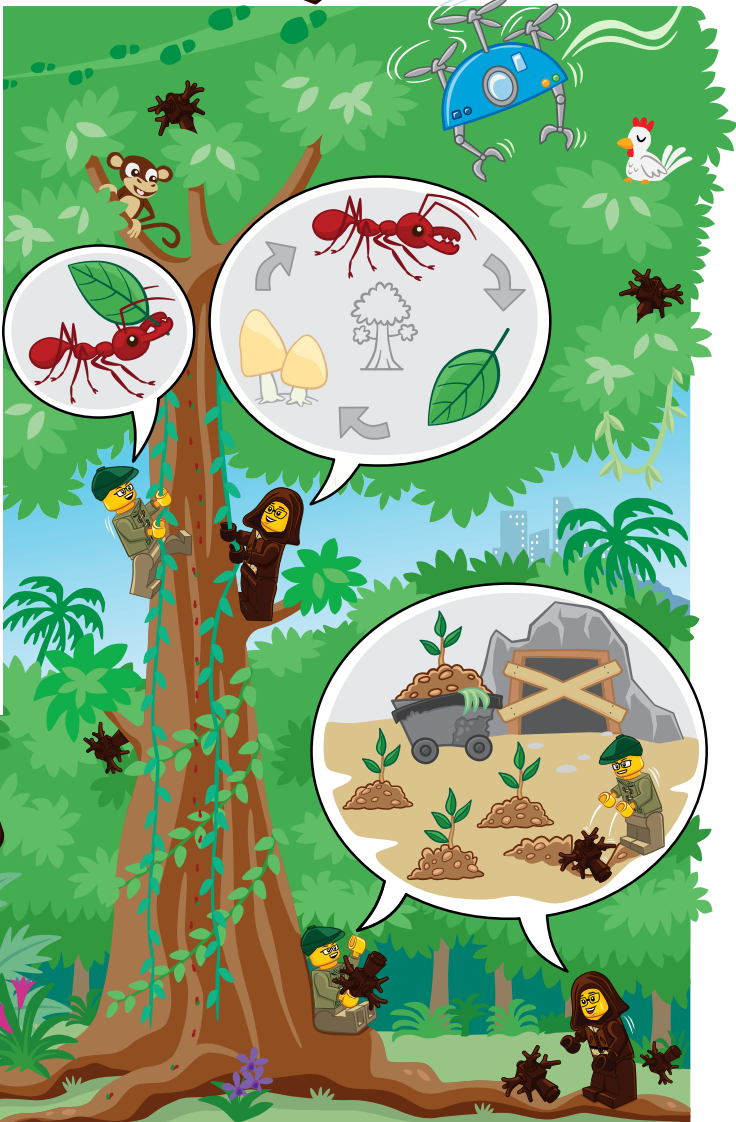
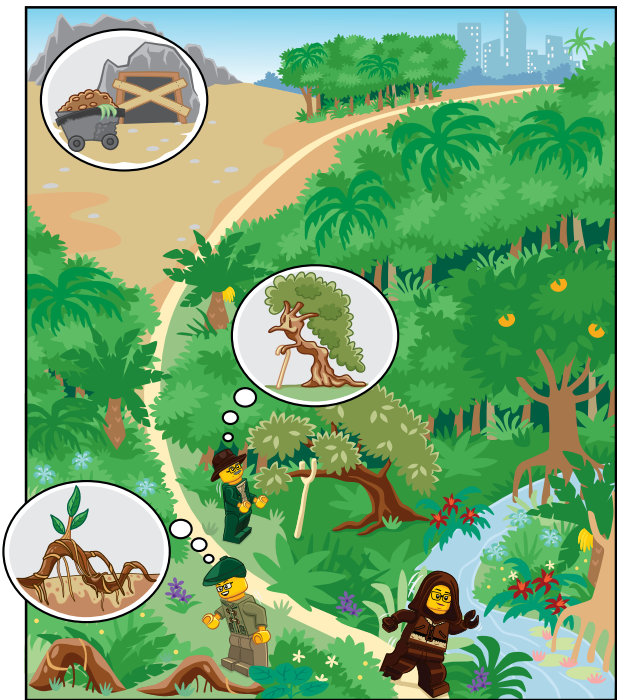
Conservationists sometimes use mapping technology to study how forests change over time, allowing them to guide conservation efforts.

How could you restore a piece of land to benefit the native plants and animals?

Forest Floor



Challenge Story



Team Progress

Come back to this page throughout your season to update your team's goals and share your progress.

START HERE

We will use Core Values to . . .

We want our robot to . . .

We want our innovation project to . . .

HALFWAY THERE

So far, I have learned . . .

I want to learn more about . . .

EVENT TIME

I am proud of my team because we . . .

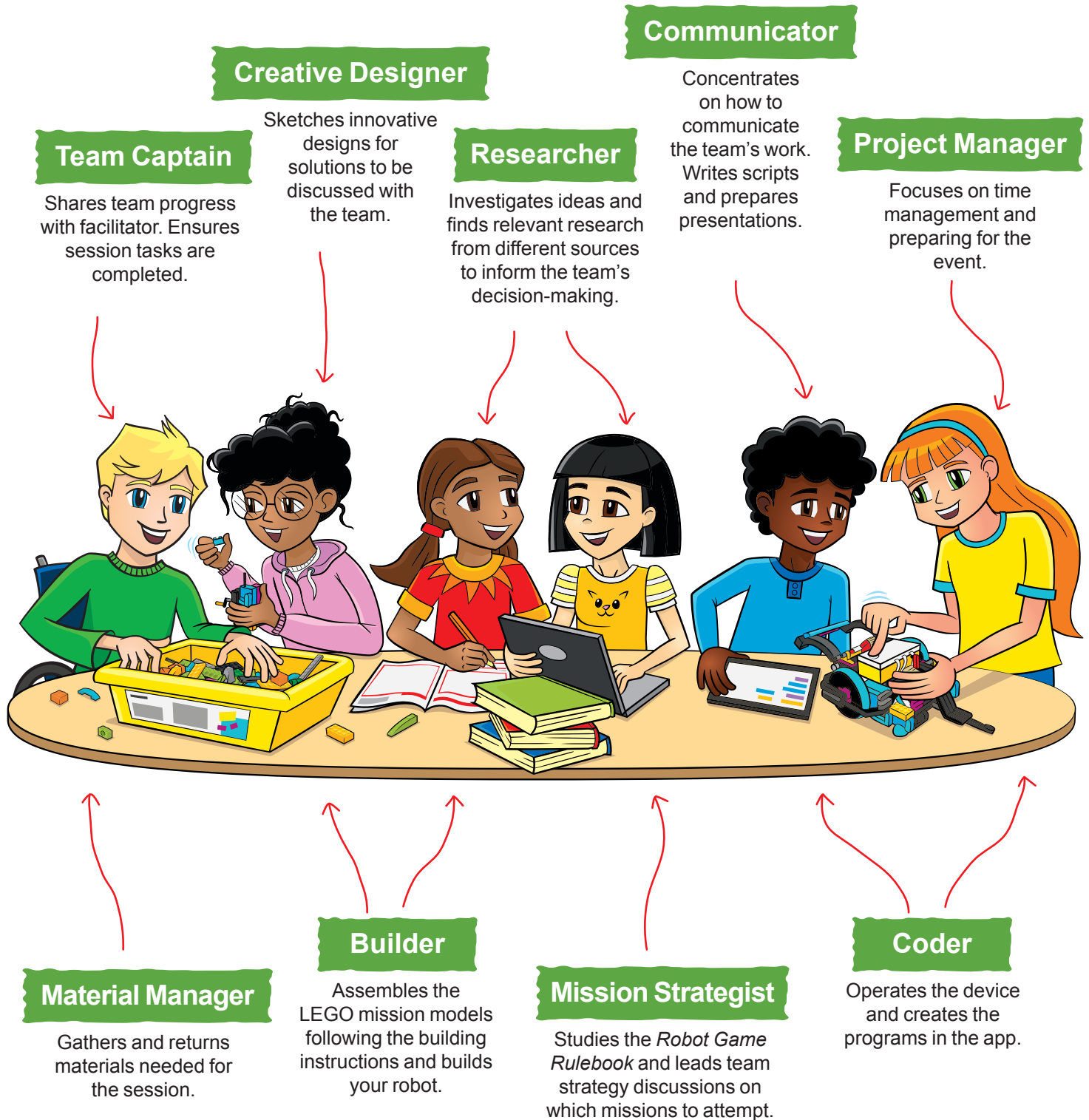
Try these goal prompts
for inspiration!



Team Roles

Here are example roles your team can use during the sessions. Make sure everyone on the team has the opportunity to try all the roles.

The goal is to build your team to be confident and capable in all aspects of *FIRST*® LEGO® League Challenge.



→ Introduction

- ☐ Watch the season videos and read pages 3-9 to learn how *FIRST® LEGO® League Challenge* works and about the BIOGLOW™ **robot game** and **innovation project**.
- ☐ Get to know your team members and think of a team name.

→ Tasks

- ☐ Use the building instructions to build the robot game mission models.
- ☐ Set up the game field. Read page 7 of the *Robot Game Rulebook* to learn how to set up the mat.
- ☐ Explore how the models work and how they connect to the Project Sparks on page 6.
- ☐ Discuss the reflection questions and record your progress.

→ Clean Up

→ Reflection Questions

- How do the mission models relate to the Project Sparks?
- Which mission models look interesting to you?
- How does your team plan to have fun while working on the game and project?

Tip

During each meeting, record what you have learned and what you want to improve on.

Session 1

Use the note space to record information about your team and what you worked on.

Our notes:



The Season Resources page is where you can find links to all videos, instructions, and materials your team will need!

Session 2

Discovery: We explore new skills and ideas.

Our notes:

→ Introduction

- ☐ Think about how you will use the Core Value of **discovery** in your team's journey.
- ☐ Record what your goals are and what you hope to learn on the Team Progress sheet on page 8.

→ Tasks

- ☐ Open the SPIKE™ app. Find your lesson.



Tutorial Activities:
1-6 (optional)



Competition Ready
Unit: Training
Camp 1: Driving Around

- ☐ Use the skills you learned to navigate your robot to one of the mission models.
- ☐ Talk to your team about your ideas for the innovation project.
- ☐ Discuss the reflection questions and record your progress.

→ Clean Up

→ Reflection Questions

- What coding and building skills did you learn that you can apply in the robot game?
- How did you use the **Engineering Design Process** in this session?
- What Project Sparks interest your team? How will your team research the problem?

Tip

Try using the Pseudocode worksheet on page 28 to map out your robot's path and programming steps.

→ Introduction

- ☐ Review the innovation project information on page 5 and the Project Sparks on page 6.
- ☐ Pick a Project Spark or one of your own ideas and think of the problem your team will explore.

→ Tasks

- ☐ Record your team's problem statement on page 29.
- ☐ Open the SPIKE™ app. Find your lesson.



**Competition Ready Unit:
Training Camp 2: Playing
with Objects**

- ☐ Talk about the skills you learned in this lesson and how they will help you in the robot game.
- ☐ Try it out! See if you can code your robot to attempt a mission.
- ☐ Discuss the reflection questions and record your progress.

→ Clean Up

→ Reflection Questions

- What additional research is necessary to select an idea for the project?
- What objects does your robot need to avoid in the robot game?
- What mission does your team want to attempt next?

Tip

Consider why the problem exists, why it is important to fix, and who would be affected if the problem were solved.

Session 3

A problem statement describes the problem that your team wants to solve.

Our notes:



Session 4

A mission strategy determines which missions to attempt and the order you will attempt them.

Our notes:



→ Introduction

- ☐ Work as a team to identify what research is needed to learn about existing solutions.
- ☐ Determine how your team will create your innovation project solution.

→ Tasks

- ☐ Open the SPIKE™ app. Find your lesson.



**Competition Ready Unit:
Training Camp 3:
Reacting to Lines**

- ☐ Talk about the skills you learned in this lesson and how they will help you in the robot game.
- ☐ Try it out! See if you can use the skills you learned to attempt another mission.
- ☐ Discuss the reflection questions and record your progress.

→ Clean Up

→ Reflection Questions

- How will your team record your research on your project problem?
- How did testing your program help make your robot more accurate?
- How could you use the lines on the mat in your mission strategy?

Tip

As you try to complete missions in the robot game, record what works and what your team wants to improve.

→ Introduction

- ☐ Think about **teamwork** and your team. Talk about ways your team has been learning and working together.

→ Tasks

- ☐ Continue to research the problem you have chosen.
- ☐ Use this page and page 29 to capture your research.
- ☐ Decide whether your team will propose a new solution or improve on an existing one.
- ☐ Select a solution to develop with your team.

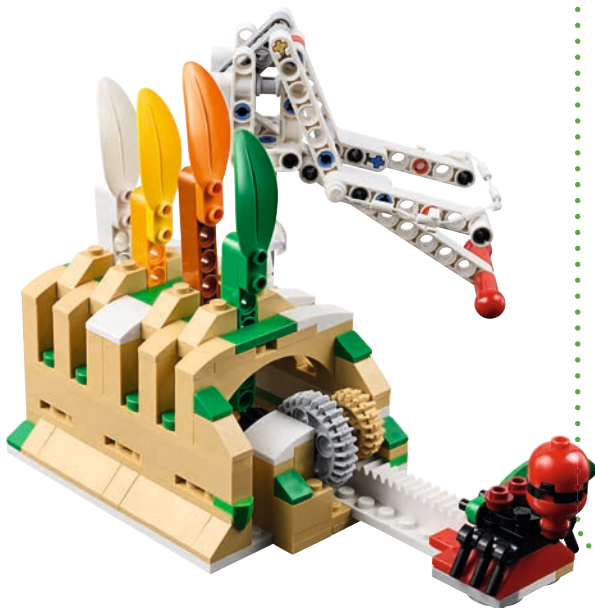
Tips

- Existing solutions could be adapted and combined with other ideas.
- List what you learned about the problem and solutions and provide the resources you used (e.g., books, news articles, or interviews).

Session 5

Teamwork: We are stronger when we work together.

Innovation project notes:



Robot game notes:



Tip

Coopertition means that teams help and cooperate with each other, even as they compete.

→ Tasks

- ☐ Open the SPIKE™ app. Find your lesson.



Competition Ready Unit: Guided Mission



Competition Ready Unit: Assembling an Advanced Driving Base (optional)

- ☐ Practice the guided mission until it works consistently.
- ☐ Continue attempting other missions in the robot game.
- ☐ Discuss the reflection questions and record your progress.

→ Clean Up

→ Reflection Questions

- Who could your team talk to about the problem you selected? What questions would you ask them?
- How will your team work together to develop an innovative solution to the problem?
- What does the robot game teach you about **Coopertition**®?
- How could you use what you learned in the guided mission to complete additional missions?



→ Introduction

- ☐ Talk about **innovation** and share examples of how your team has been creative while solving problems.
- ☐ Complete the “Halfway There” section of the **Team Progress** sheet on page 8.

→ Tasks

- ☐ Plan how you will develop a solution to your problem. Use the **Innovation Project Planning** sheet on page 29 to record your steps.
- ☐ Use a variety of sources and keep track of them in this *Engineering Notebook*.
- ☐ Determine what materials may be needed to create a prototype model or drawing of your solution.

Session 6

Innovation: We use creativity and persistence to solve problems.

Innovation project notes:



Tip

Look at the innovation project rubric to learn what the judges will ask about your solution.

Pseudocode is a written description of the steps for your planned robot program.

Robot game notes:

→ Tasks

- ☐ Review the “Robot Game Missions” video and *Robot Game Rulebook*.
- ☐ Complete the Pseudocode sheet for a selected mission on page 28.
- ☐ Upload your program ideas to your robot using the SPIKE™ app and test them.
- ☐ Continue to practice completing missions in the robot game.
- ☐ Discuss the reflection questions and record your progress.

→ Clean Up

→ Reflection Questions

- What is the next step in developing your innovation project solution?
- How will documenting your progress on the innovation project help your team’s judging session at the event?
- How can your robot’s attachments and code support your team’s mission strategy?
- How can you iterate to improve your robot design used in previous tasks?



Tip

Think about what attachments and sensors you will use during the game and how you will change them.

→ Introduction

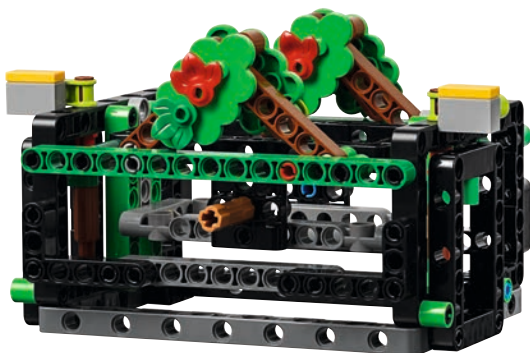
- ☐ Talk about **Gracious Professionalism** and the ways your team demonstrates this in everything you do.

→ Tasks

- ☐ Continue to develop your innovation project solution.
- ☐ Draw your solution and discuss how it solves the problem.
- ☐ Create a prototype model or detailed drawing of your solution.
- ☐ Continue to document the process you use to develop your solution on the Innovation Project Planning sheet and throughout this *Engineering Notebook*.

Tip

The prototype does not need to be functional but should help you to explain your solution to others.



Session 7

Gracious Professionalism®: We show high-quality work, emphasize the value of others, and respect individuals and the community.

Innovation project drawing and notes:

Practice explaining how the program on your device is making your robot move.

Robot game notes:



→ Tasks

- ☐ Discuss which missions your team has attempted and which missions you still want to try.
- ☐ Continue to test and improve your robot and its attachments to complete missions in the robot game.
- ☐ Create a program for each new mission you attempt or combine mission solutions into one program.
- ☐ Revisit previous lessons to develop your coding skills or work on solving the missions.
- ☐ Discuss the reflection questions and record your progress.

→ Clean Up

→ Reflection Questions

- Can you describe your solution in a way that is easy for others to understand?
- Who can you share your solution with for feedback?
- How can you iterate to improve your robot design or your attachments?
- How do you determine if your robot is successful at a mission or if it needs improvements?

Tip

You can improve the robot used in the previous sessions or create a new design.



→ Introduction

- ☐ Talk about inclusion and share examples of how your team makes sure everyone is respected and their voices are heard.

→ Tasks

- ☐ Share and collect feedback on your ideas. Use page 29 to record the feedback.
- ☐ Decide what feedback to use to iterate on your solution.
- ☐ Determine if you can test your updated solution.

Tip

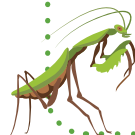
Seeking advice from others, even other teams, is a great way to learn and improve your skills.



Session 8

Inclusion: We respect each other and embrace our differences.

Innovation project notes:



Think about how you can use simple building techniques in a creative way to solve missions.

Robot game notes:

You could:

Describe the attachments you built.

Explain your different programs and what the robot will do.

Explain your robot design while looking at the rubric criteria.



→ Tasks

- ☐ Choose another robot game mission to work on.
- ☐ Think about how each new mission fits into your mission strategy.
- ☐ Iterate and refine your program and attachments so your robot completes the mission reliably.
- ☐ Document your design and testing process for each mission.
- ☐ Discuss the reflection questions and record your progress.

→ Clean Up

→ Reflection Questions

- What changes will you make to your project solution after getting feedback?
- How does your team decide which missions to attempt?
- In what order will you run the missions in the robot game?
- How has your team used Core Values to develop your robot and project solution?



Tip

Judges will want to hear what changes you made along the way to understand your design and testing process.

→ Introduction

- ☐ Think about impact and share examples of how your team has had a positive influence on you and others.

→ Tasks

- ☐ Think about your robot mission strategy on the mat and the missions you will solve.
- ☐ Continue to practice missions.
- ☐ Iterate and improve your robot and innovation project solutions.
- ☐ Discuss the reflection questions and record your progress.

→ Clean Up

→ Reflection Questions

- How will your team demonstrate Core Values at the event?
- How will your team explain what is innovative about your project to judges?
- What changes have you made to your innovation project and robot design based on feedback and testing?

Session 9

Impact: We apply what we learn to improve our world.

Our notes:

Tip

Your team's Core Values are evaluated using the robot design and innovation project rubrics. Visit page 3 to see all Core Values listed.



Session 10

Coopertition®: Teams help and cooperate with each other, even as they compete.



Our notes:

→ Introduction

- ☐ Talk about *Coopertition*® and the ways your team will demonstrate it when competing with other teams.

→ Tasks

- ☐ Look at the innovation project rubric for what to include in your five-minute presentation.
- ☐ Plan your project presentation by writing an outline or script.
- ☐ Create any visual displays you need. Engaging your audience can help ensure they remember your key points.
- ☐ Continue to create, test, and iterate on your robot solution.
- ☐ Continue practicing 2.5-minute robot games with all the missions you have worked on.
- ☐ Discuss the reflection questions and record your progress.

→ Clean Up

→ Reflection Questions

- How will you know if your solution is going to make a positive impact on others?
- What is your team most proud of in your work on the project and robot design?
- What skills have you developed throughout your *FIRST* LEGO League experience?



Tip

Create an outline to make sure you are sharing what the judges need to hear. Look at the rubrics and the judging session flowchart for support.



→ Introduction

- ☐ Talk about how your team has had fun while exploring the season theme and share examples of how your team has celebrated your hard work.
- ☐ Complete the “Event Time” section of the Team Progress sheet on page 8.

→ Tasks

- ☐ Look at the robot design rubric to learn about what to include in your five-minute explanation.
- ☐ Plan your robot design explanation by creating an outline or script.
- ☐ Make sure to share how each member of the team contributed to the project and robot design.
- ☐ Continue to develop and practice your project presentation and collect feedback.
- ☐ Discuss the reflection questions and record your progress.

→ Clean Up

→ Reflection Questions

- Which parts of your robot show how you used the Engineering Design Process?
- How are everyone’s contributions recognized in the presentation?
- How has *FIRST* LEGO League made a difference for you?

Tips

- 🌸 It’s important to share the progress your team has made and the lessons you have learned.
- 🌸 Plan to talk about your robot design and game strategy without the robot game field.

Session 11

Fun: We enjoy and celebrate what we do!

Our notes:



Session 12

Take pride in what you've accomplished this season and enjoy the experience of sharing it with others.

Our notes:



→ Introduction

- ☐ Look at your team's goals listed on page 8. Did you achieve them?
- ☐ Review page 26, Prepare for Your Event, and page 27, Rubrics & Scoresheets.

→ Tasks

- ☐ Rehearse your judging presentation by communicating your innovation project and explaining your robot design.
- ☐ Collect feedback on your presentation from your coach, mentor, or another team.
- ☐ Practice multiple 2.5-minute robot game matches and calculate the points you score.
- ☐ Practice your project presentation and your robot design explanation.
- ☐ Make a list of everything you will need to bring to the event.
- ☐ Discuss the reflection questions and record your progress.

→ Clean Up

→ Reflection Questions

- What has your team accomplished?
- What will you do if a mission does not work during a match?
- What is your plan for having your team's robot attachments ready for the robot game?
- What else does your team need to work on before the event?

Tip

Continue practicing missions and working on your innovation project leading up to your event!

Event Preparation



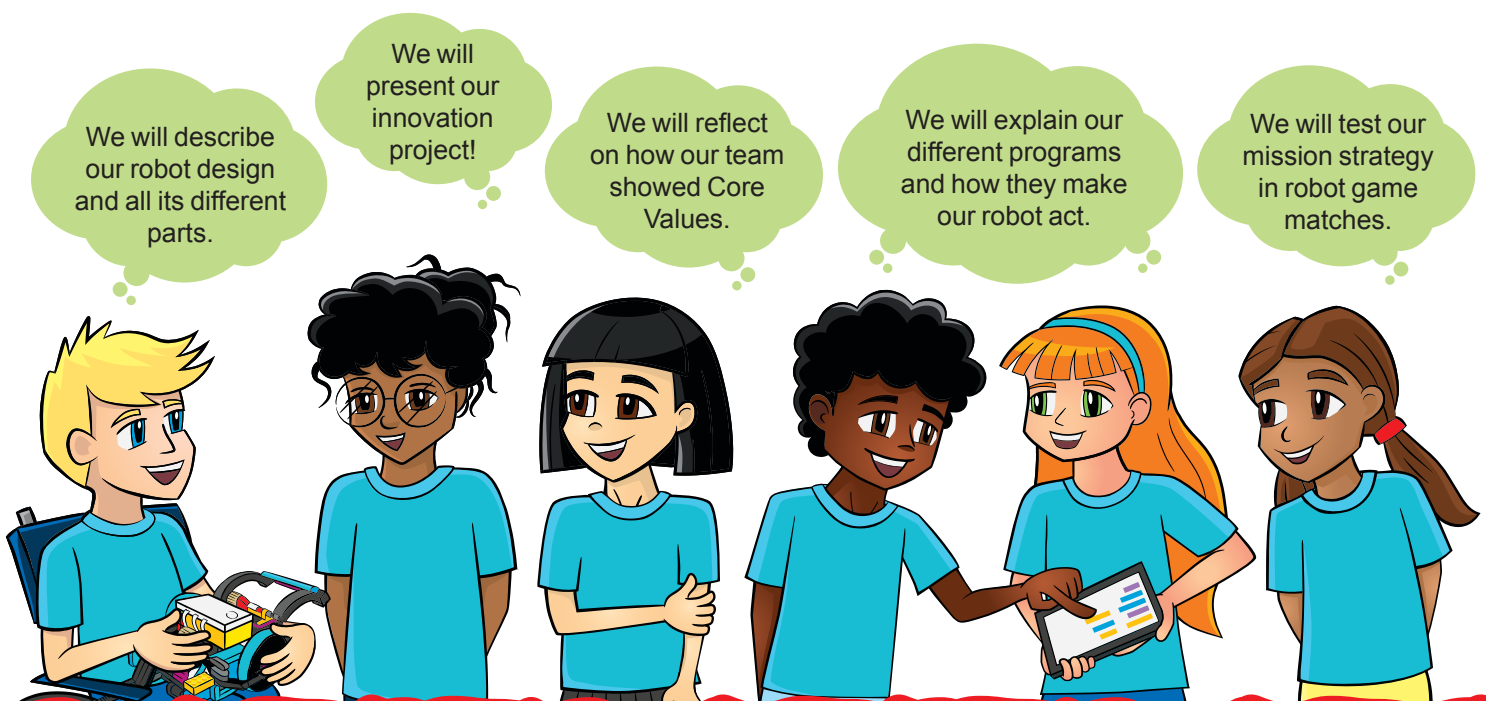
- ☐ **Make a packing list.** You'll at least need your robot and attachments, device with your programs, chargers, project and judging materials (poster, model, or visuals), and any team notes.
- ☐ **Practice and plan the day.** Review the event schedule and practice your innovation project and robot design presentations. Decide who will present each part during judging and confirm who will do what at the robot game.
- ☐ **Think about your innovation project.** Can you describe the problem you chose and how it connects to the season theme? How did you share your solution and iterate based on feedback? What is innovative about your solution and how could it help others?
- ☐ **Think about your robot design and mission strategy.** Which missions did your team attempt to solve and what resources helped you learn how to build and code your robot? How will you describe what each member of your team contributed and the improvements you made along the way?
- ☐ **Reflect on the Core Values your team has used.** Think back on your season and be ready to share how your team worked together, how you overcame challenges, and what you learned from your journey.

Tips for a Great Event Day

- ☐ Stay organized by knowing your schedule and where you need to be. Arrive on time, keep track of your materials, and be ready for your judging session and robot game matches.
- ☐ Support your teammates and communicate clearly. Encourage each other, solve problems together, and remember that teamwork is one of your biggest strengths.
- ☐ Be flexible and stay positive. Not everything may go as planned, but how you respond to challenges shows your *Gracious Professionalism*.
- ☐ Most importantly, have fun and celebrate your hard work!



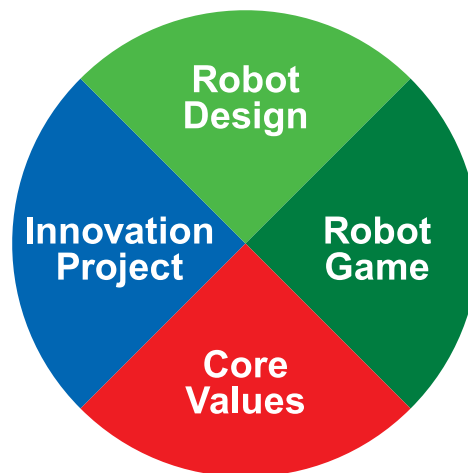
Watch this video to prepare for your event.



Rubrics & Scoresheets

FIRST LEGO League is evaluated equally in four areas: Core Values, Innovation Project, Robot Design, and Robot Game. Judges will use rubrics and referees will use scoresheets to assess your work and provide feedback.

Make sure you review the rubrics and scoresheets before your event. Understanding how you are evaluated will help your team compete confidently.



Judging Rubrics

Session Flowchart

The **rubrics** outline what judges are looking for during your session, and the **flowchart** shows the order you should present your work. It is your team's job to explain everything to the judges during the session. Judges may ask questions to learn more and will give feedback at the end of the session.

During the robot game, referees will use scoresheets to record your results. You'll have multiple matches to try your mission strategy, and only your highest score will count.

Core Values are evaluated both in judging and during the robot game. In the judging session, your team will share how you applied Core Values throughout your season. During the robot game, referees will observe how your team demonstrates *Gracious Professionalism*.



Judging and Scoring Materials



Pseudocode Worksheet

Go to the app and start a new project. Explore which coding blocks will move your robot the same way as your planned coding steps would move it.

Mission Name:

Mission Number:

Move 1

Move 6

Move 2

Move 7

Move 3

Move 8

Move 4

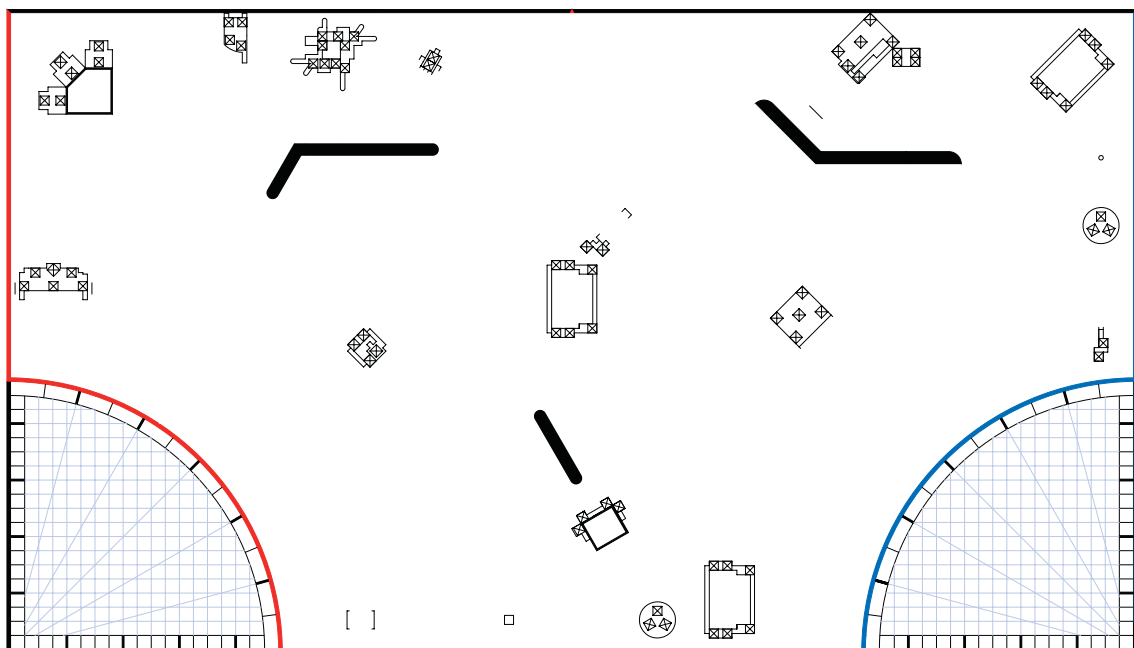
Move 9

Move 5

Move 10

ROBOT PATH DIAGRAM

Draw the route your robot will take to complete the mission.



Innovation Project Planning

PROBLEM STATEMENT

Complete during Session 3.

RESEARCH

Complete during Session 5.

SOLUTION PLANNING

Complete during Session 6.

FEEDBACK

Complete during Session 8.

SUMMARIZE YOUR PROJECT

Complete before your event.

Remember to check the rubric to learn what the judges will want to know during the judging session.



Robot Design Notes

Mission	Attempted	Notes
		
		
		
		
		
		
		



ATTACHMENT NOTES

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PROGRAM NOTES

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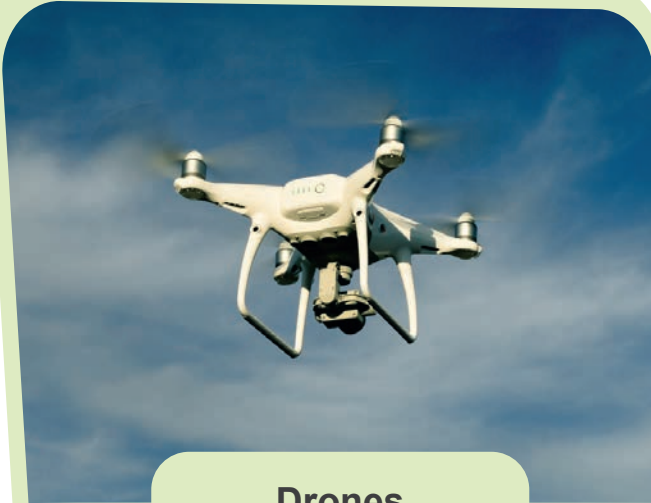
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Technology Connections

Career
Resources



Drones

Researchers use thermal imaging sensors on drones to detect wildlife without disturbing them. Some teams map trees from above using cameras and other drone attachments.



Plant Study Tools

Ecologists use sensors to check nutrient levels in soil and to understand how plants get what they need to survive. They may also use weather equipment to track sunlight and humidity around growing plants.



Animal Monitoring Tools

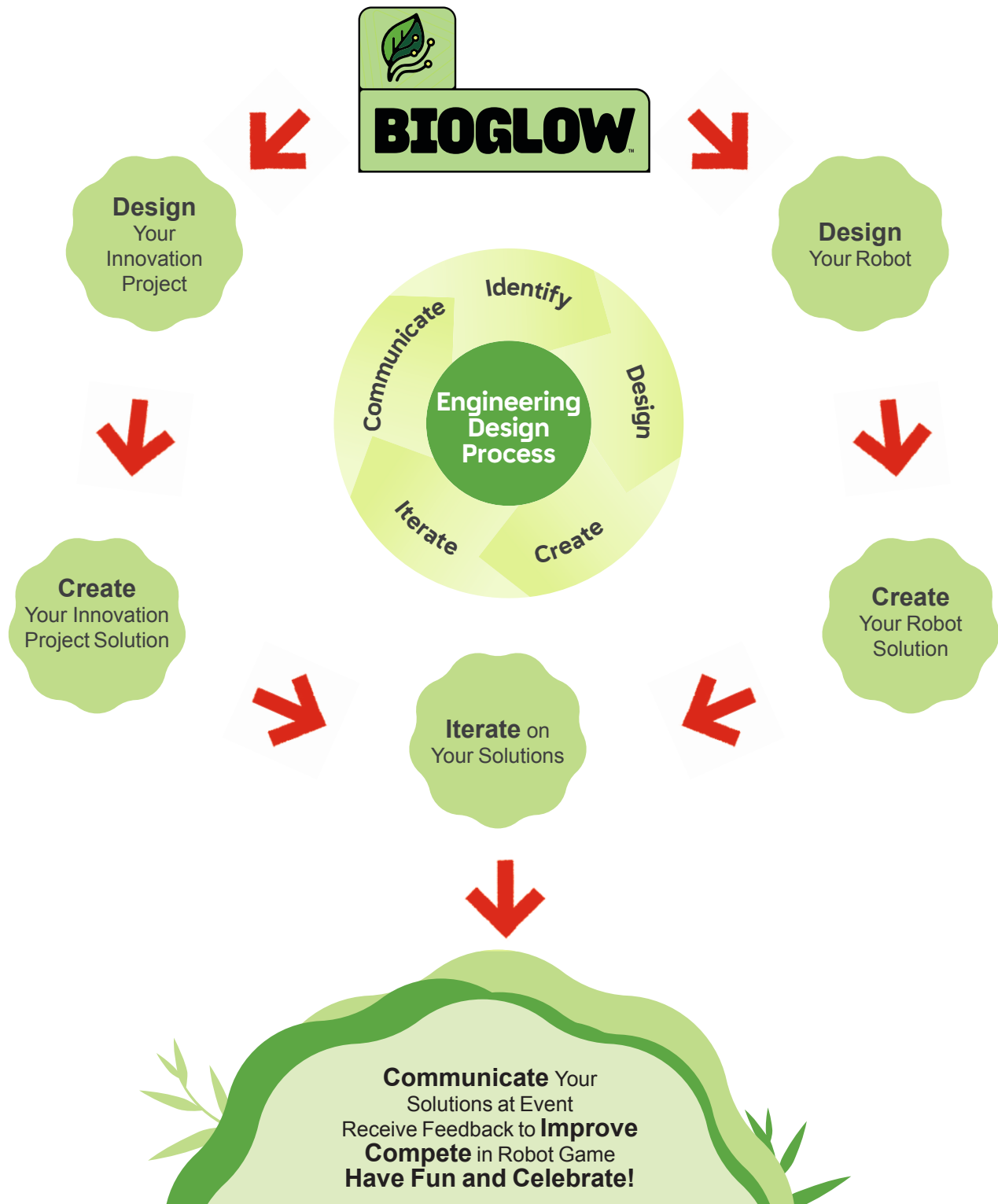
Wildlife biologists use trail cameras and acoustic recorders to observe animals and to measure biodiversity. By listening to animal calls, scientists can determine how diverse an area is and learn how they can help improve biodiversity.



Conservation Tools

Conservationists may focus their work on specific species or an entire area, creating a wide range of skill sets. They may improve biodiversity by planting trees, cleaning waterways, or using mapping technology to monitor ecosystems from planes or satellites.

Team Journey



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