FIRST LEGO LEAGUE CHALLENGE

TEAM MEETING GUIDE

MASTERPIECE℠

FIRST®

LEGO education™

Introduction to *FIRST®* LEGO® League Challenge

Friendly competition is at the heart of *FIRST®* LEGO® League Challenge, as teams of up to 10 children engage in research, problem-solving, coding, and engineering as they build and code a LEGO® robot that navigates the missions of the robot game. Teams also participate in an innovation project to identify and solve a relevant real-world problem.

FIRST LEGO League Challenge is one of three divisions by age group of the *FIRST* LEGO League program. This program inspires young people to experiment and grow their confidence, critical thinking, and design skills through hands-on learning. *FIRST* LEGO League was created through an alliance between *FIRST®* and LEGO® Education.

FIRST® IN SHOW℠ Presented by Qualcomm and MASTERPIECE℠

Welcome to the *FIRST®* IN SHOW℠ season presented by Qualcomm. This year's *FIRST* LEGO League challenge is called MASTERPIECE℠. Children will learn about how we share our own hobbies and interests while learning about experts in museums, theaters, and other creative fields.

People who work in the arts can teach us a lot about how to communicate, how to engage, and how to entertain an audience of any size. The team will use critical thinking and innovation to inspire others to learn and be entertained!

Program Outcomes

The team will:
- Use and apply the *FIRST* Core Values and engineering design process to develop robot and innovation project solutions.
- Identify and research a problem related to the season theme and then design and create an innovation project solution.
- Identify a mission strategy and design, create, and code a robot to complete missions.
- Test, iterate, and improve their robot design and innovation project.
- Communicate their robot design and innovation project and demonstrate their robot in the robot game.
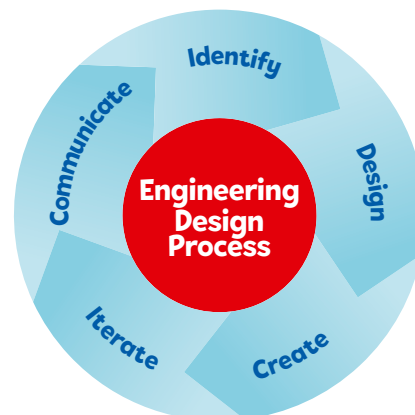
Overview

How to Use This Guide

The sessions provide a guided experience for the *FIRST*® LEGO® League Challenge. The sessions are designed to be flexible so that teams of varying experiences can use the materials. Your role is to facilitate and guide the team during the sessions to complete the team tasks. The tips within this guide are just suggestions. Remember to do whatever is best for you and your implementation.

FIRST® Core Values

The *FIRST*® Core Values are the cornerstones of the program. *Gracious Professionalism*® is a way of doing things that encourages high-quality work, emphasizes the value of others, and respects individuals and the community. The team's Core Values and *Gracious Professionalism* are evaluated during robot game matches and during the judging session at the tournament. The team demonstrates *Coopertition*® by showing that learning is more important than winning and that they can help others even as they compete.
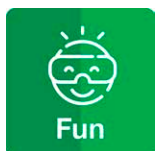
Teamwork — We are stronger when we work together.

Inclusion — We respect each other and embrace our differences.

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

Fun — We enjoy and celebrate what we do!

Discovery — We explore new skills and ideas.

Innovation — We use creativity and persistence to solve problems.

What Does the Team Need?

LEGO® Education SPIKE™ Prime Set

Core set

Expansion set

Note: *Other LEGO® Education sets such as MINDSTORMS® and Robot Inventor are also allowed.*

Electronic Devices

Each team will need two compatible devices such as a laptop, tablet, or computer. Prior to starting Session 1, you need to download the appropriate software (LEGO® Education SPIKE™ Prime or other compatible software) on to the device.

MASTERPIECE℠ Challenge Set

This challenge set comes in a box that contains the mission models, challenge mat, and some miscellaneous pieces. The team should build the models very carefully using the building instructions. The miscellaneous items include 3M™ Dual Lock™ Reclosable Fasteners, coach pins, and season tiles for the team members.

Mission Model Building Instructions

Challenge Mat and Table

Set up a table with the challenge mat in your classroom or meeting space. Even if you cannot build the whole table, building just the four walls will be useful. It is also possible to use the mat on the floor.

Sessions at a Glance

	Introduction (10-15 minutes)	Team Tasks (100-120 minutes)		Share (10-15 minutes)
Session 1 Museum Curator	Introduction to Challenge	Tutorial Activities	Museum Curator	Share
Session 2 Visual Effects Director	Goals and Processes	Training Camp 1: Driving Around	Visual Effects Director	Share
Session 3 Stage Manager	Team Design	Training Camp 2: Playing with Objects	Stage Manager	Share
Session 4 Sound Engineer	Discovery Examples	Training Camp 3: Reacting to Lines	Sound Engineer	Share
Session 5 Investigate Ideas	Teamwork Examples	Guided Mission	Identify Project	Share
Session 6 Identify Solutions	Innovation Project Build	Pseudocode and Mission Strategy	Plan Innovation Project Solution	Share
Session 7 Create Solutions	*Gracious Professionalism*® Examples	Solve Missions	Develop Project Solution	Share
Session 8 Continue Creating	*Coopertition*® Examples	Solve Missions	Evaluate and Test Project Solution	Share
Session 9 Solution Planning	Innovation Examples	Iterate and Improve Robot Solution	Iterate and Improve Project Solution	Share
Session 10 Iterate Solutions	Impact Examples	Iterate and Improve Robot Solution	Plan Project Presentation	Share
Session 11 Presentation Planning	Inclusion Examples	Plan Robot Design Explanation	Practice Project Presentation	Share
Session 12 Communicate Solutions	Fun Examples	Practice Robot Game Matches	Practice Full Presentation	Share

Management Tips

FACILITATOR TIPS

- Determine your timeline. How often will you meet and for how long? How many meetings will you have before your tournament?

- Set team guidelines, procedures, and expected behaviors for your meetings.

- Get into the mindset that the team will be doing the work. You will facilitate their journey and remove any major obstacles.

- Guide your team as they work independently through the tasks provided in each session.

- Use the guiding questions in the sessions to provide focus and direction to the team.

- Jobs are listed in some sessions that connect to the Career Connections pages in the back of the *Engineering Notebook*.

- Teammates should be encouraged to work with each other, listen to each other, take turns, and share ideas.

MATERIAL MANAGEMENT

- Place any extra or found LEGO® pieces in a cup. Have kids who are missing pieces come to the cup to look for them.

- Wait to dismiss your team until you look over their LEGO set.

- The lid of the LEGO set can be used as a tray to keep pieces from rolling away.

- Use plastic bags or containers to store any unfinished builds or assembled models.

- Designate a storage space for the built mission models and challenge mat/table.

- The Material Manager role can help with the process of clearing away and storing materials.

ENGINEERING NOTEBOOK TIPS

- Read the *Engineering Notebook* carefully. The team will share the notebooks and work on them collaboratively.

- The notebook contains relevant information and guides the team through the sessions.

- The tips in this *Team Meeting Guide* will direct you how to support each session.

- As facilitator, guide the team members in the performance of their roles during each session.

- Team roles are outlined in the *Engineering Notebook*. Using roles helps your team function more efficiently and ensures that everyone on the team is involved.

Pre-Session Checkpoint

Please read the student *Engineering Notebook*, *Robot Game Rulebook*, and this *Team Meeting Guide* before starting the sessions.

The guides are full of very useful information to guide you through this experience. Use this checkpoint to help you get started and guide you toward success.

0 —— 1 —— 2 —— 3

- [ ] Explore the *FIRST®* Core Values. These are the essential foundation for your team.
- [ ] Watch the season videos on the *FIRST®* LEGO® League YouTube channel.
- [ ] Unpack the robot set and sort the LEGO elements into the trays.
- [ ] Have the team look over the judging rubrics to see the evaluation criteria for their robot and innovation project solutions.

- [ ] Make sure the controller is charged and all updates are completed.
- [ ] Ensure you have at least two devices with Internet access and the appropriate LEGO® Education app installed per team.
- [ ] Scan the QR code for additional support resources and links.

Sessions 1-4 Tips

CORE VALUES

Have the team set goals for what they want to accomplish together, and have individual team members set their personal goals.

ROBOT DESIGN

If the team is new to using their LEGO Education robot set, take some time to get them acquainted with the set. Have the team complete the Getting Started activities.

INNOVATION PROJECT

Sessions 1-4 provide four different Project Sparks that provide example problems and solutions to the innovation project.

ROBOT GAME

Have a location to place the mat and models after each session if they have to be stored.

Session 1

Outcomes

Season Videos

The team will:
- Learn how to connect and use the sensors and motors.
- Make connections from the mission models to the museum curator Project Spark ideas.

1 Have the team watch the season videos on the *FIRST*® LEGO® League YouTube channel and read pages 3-9 in their *Engineering Notebooks*.

2 Two devices are suggested, one for the robot and one for project work. Additional devices for the mission model building are useful.

3 Activities in the sessions use the LEGO Education SPIKE™ Prime app.

4 Make sure the controller and device are plugged in and charging at the end of the session.

5 Robot Game Connection: Have the team think about how a sensor could be helpful to get the robot to stop in the right place to engage with a mission model on the mat.

Estimated times are provided for each part of the session.

1 → **Introduction**
(10-15 minutes)
☐ Watch the season videos and read pages 3-9 on how *FIRST*® LEGO® League Challenge works and the MASTERPIECE℠ challenge.

2 → **Tasks**
(50-60 minutes)
☐ Open the SPIKE™ Prime app. Click the Start button.

3 **Tutorial Activities: 1-6**

☐ Check out the *Robot Game Rulebook* for mission details.

4

→ **Reflection Questions**
- How could stopping a motor help you solve a mission with your robot?
- What do you know about your teammates' interests and hobbies?
- What are resources that can help you learn more?

5

Session 1

What are the four parts of *FIRST* LEGO League Challenge?

Every session has an Introduction prompt and space to document the team's responses.

Our Notes:

Open space is provided in each session for the team to collaboratively capture their thoughts, ideas, diagrams, and notes.

Some sessions will have helpful tips for the team.

The Robot Game Rulebook is a great resource to use throughout the sessions.

Museum Curator

Facilitator Tips

Each session in this guide takes two hours. If needed, split each session into two separate 60-minute meetings by having the team complete each page in a 60-minute meeting. Sessions 1-4 may take additional time to complete the builds.

See page 23 in the *Robot Game Rulebook* for a summary of the mission models and their bag numbers.

Museum Curator

(8)

Project Spark

Museums are places where people learn about art, culture, science, history, and more. Technology is often used to make learning more interesting and engaging.

Think about and research:
• Who visits museums and why?
• What kind of technology is used to help people interact with a museum exhibit?
• Who are the people that work behind the scenes at a museum?
• How do museums protect and preserve their exhibits and artifacts?

Our Ideas:

Project Sparks provide the team ideas for their innovation project and how the mission models connect to the theme.

The team can use these reflection questions during the Share time. Sharing at the end is an important way for the team to summarize and reflect.

Some sessions will have callouts to energy-related careers that tie to jobs listed in Career Connections pages.

Anna

What technology used at the museum will give Izzy ideas for her assignment?

→ Tasks
(50-60 minutes)
☐ Read the Project Spark.
(6) ☐ Build the Museum Curator models in Bags 3, 5, and 11.
(7) ☐ Review the missions that relate to the models you built.
☐ Discuss how the mission models are linked to the Project Spark.
☐ Capture your ideas.

→ Share
(10-15 minutes) **(9)**
☐ Get together at the mat.
☐ Refer to the field setup section of the *Robot Game Rulebook* for the models pictured below.
(10) ☐ Place each model where it belongs. Show the robot skills you learned.
☐ Show how the models work and explain how they relate to the Project Spark.
☐ Discuss the reflection questions.
☐ Clean up your space.

→ Reflection Questions
• What innovation project ideas do the mission models spark?
• What kind of technology do museums in your community use?

M03   M05   M12

(6) Provide the digital building instructions for the models to the team.

(7) The team will need Bags 3, 5, and 11 from the Challenge set. Larger pieces may be in an unnumbered LEGO® bag.

(8) The Project Sparks are designed to give the team ideas about technology they could explore for their solution.

(9) Encourage the team to investigate the mat and the mission models to inspire them. The team should record ideas for possible innovation projects that they could choose.

(10) Place the completed models on the mat with Dual Lock squares according to the field setup in the *Robot Game Rulebook*.

Session 2

Outcomes

The team will:
- Build a driving base and code it to move forward, move backward, and turn.
- Make connections from the mission models to the visual effects director Project Spark ideas.

1 Example prompts for goal setting are provided in the *Engineering Notebook*.

2 Remind the team to back up saved program files.

3 After a program is downloaded onto the controller, it cannot be transferred back to be opened and edited.

4 Have the team practice their new skills by trying to drive the robot to a model and then returning to home.

5 Robot Game Connection: Have the team code the robot to push an object and deliver it to a target area on the mat.

Session 2

1 → **Introduction**
(10-15 minutes)

☐ Think about some goals you want to achieve. These can grow and change throughout your journey.

☐ In this session, use the engineering design process and try out using the team roles listed on page 8.

2 → **Tasks**
(50-60 minutes)

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

Competition Ready Unit: Training Camp 1: Driving Around

3
☐ Determine what coding and building skills you can apply in the robot game.

☐ Try it out! Which missions look like the most fun?

4 See if you can use the skills you learned to drive your robot to one of the mission models.

5

→ **Reflection Questions**
- How can you aim your robot toward a model?
- How did you use the engineering design process and team roles in this session?

My Personal Goals:

Our Notes:

Use these goal prompts for inspiration!

We will use Core Values to . . .

We want to experience . . .

We want our robot to . . .

We want our innovation project to . . .

Visual Effects Director

Some of the team may excel at model building and can help others who get stuck. If the team talks over each other, refer them to the team roles and designate one person as the communicator.

Visual Effects Director

Project Spark

Visual effects and other video and audio technology can create a powerful impact for viewers of movies and other types of media. Using innovative techniques, visual effects directors can make a movie scene really exciting and immersive!

Think about and research:
• What movies use visual effects?
• How does a visual effects director collaborate with others on a movie set?
• What tools or technology are used to help create exciting visuals?
• How can visual effects make an audience feel like they are part of the action?

Our Ideas:

➔ Tasks
(50-60 minutes)

☐ Explore the Project Spark.

6 ☐ Build the Visual Effects Director models in Bags 1, 7, and 8.

7 ☐ Look over the missions that correspond to the models.

8 ☐ Talk about how the mission models relate to the Project Spark.

☐ Capture your ideas.

➔ Share
(10-15 minutes)

☐ Get together at the mat.

☐ Place each model where it belongs. Refer to the Field Setup section in the *Robot Game Rulebook*.

☐ Share the robot skills you learned.

☐ Show how the models work and explain their connections to the Project Spark.

☐ Chat about the reflection questions.

☐ Clean up your space.

➔ Reflection Questions
• What other effects are used in movies that don't require expensive technology?
• Can you think of examples of visual effects in exhibits or live performances?

6 Provide the digital building instructions for the models to the team.

7 The team will need Bags 1, 7, and 8 from the Challenge set. Larger pieces may be in an unnumbered LEGO® bag.

8 Have the team think about how they could use one part of the visual effects story for their innovation project solution.

9 Encourage and support discussion about the Project Spark questions.

10 Check out Career Connections pages in the *Engineering Notebook* that link to jobs listed in the sessions.

Emily

How can Izzy use visual effects to immerse her new audience?
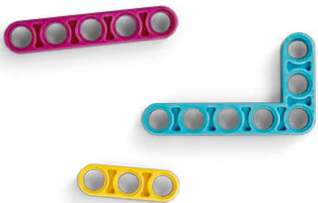
M09

M08

M01

Session 3

Outcomes

The team will:
- Code their robot to avoid obstacles using a sensor and to power an attachment.
- Make connections from the mission models to the stage manager Project Spark ideas.

1 This activity is a great way for the team to collaborate creatively on a piece that represents their shared interests.

2 Team planning and project management is important to achieve goals and be ready for the tournament.

3 Have the team check that the wires are plugged into the right ports and that the ports used match their program.

4 To make missions easier to complete, the team can build LEGO® attachments and fit them onto the robot.

5 Robot Game Connection: Have the team think about how to use the attachment from the robot lesson to complete missions.

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1 → **Introduction**
(10-15 minutes)
- ☐ Use the bricks in Bag 4 to build something that represents your team.

2 ☐ Create a team object with the bricks and be sure each person gets to contribute.

3 → **Tasks**
(50-60 minutes)
- ☐ Open the SPIKE™ Prime app. Find your lesson.

Competition Ready Unit: Training Camp 2: Playing with Objects

4 ☐ Reflect on the skills you learned that will be beneficial in completing missions.
- ☐ Try it out! See if you can code your robot to complete a mission.

5 → **Reflection Questions**
- How can you drive your robot to deliver your team object to the museum?
- What objects does your robot need to avoid?

Our Team Design:

Our Notes:

Stage Manager

Facilitator Tips

As the team completes the sessions, ask them to collect evidence of their use of the Core Values. What does each Core Value look like? What does it sound like when people are using the Core Values appropriately? How do people communicate with each other when they have a disagreement?

Stage Manager

Project Spark

A stage manager is responsible for ensuring all aspects of a live production are ready for showtime. The set, furniture, props, and costumes used on stage create lots of interest and excitement for the audience.

Think about and research:
- How can props and costumes help tell a story during a live performance?
- What skills does a stage manager need to be successful?
- Who does a stage manager work closely with in a theater?
- How could puppets be used on stage to help create excitement for the audience?

Our Ideas:

→ Tasks
(50-60 minutes)

6 ☐ Look over the Project Spark.

7 ☐ Build the Stage Manager models in Bags 2, 10, and 12.

8 ☐ Identify the missions that relate to the models you built.

9 ☐ Discuss how the Project Spark and models are linked.

☐ Capture your ideas.

10

→ Share
(10-15 minutes)

☐ Get together at the mat.

☐ Place each model where it belongs.

☐ Share how the models work and the robot skills you learned.

☐ Demonstrate the models' functions and how they connect to the Project Spark.

☐ Talk about the reflection questions.

☐ Clean up your space.

→ Reflection Questions
- What challenges could a stage manager encounter when getting ready for a show?
- What examples of live theater do you have in your community?

Sam

What equipment could Izzy use to engage her audience?

M11   M02   M13

6 Provide the digital building instructions for the models for the team.

7 The team will need Bags 2, 10, and 12 from the Challenge set.

8 Consider inviting an expert, user, or someone who works in this area to talk about the Project Sparks.

9 The team will learn about four different Project Sparks to inspire their innovation project. Have them keep notes of their ideas.

10 The team can think of ways to improve existing solutions to the Project Sparks. Their ideas don't have to be brand new.
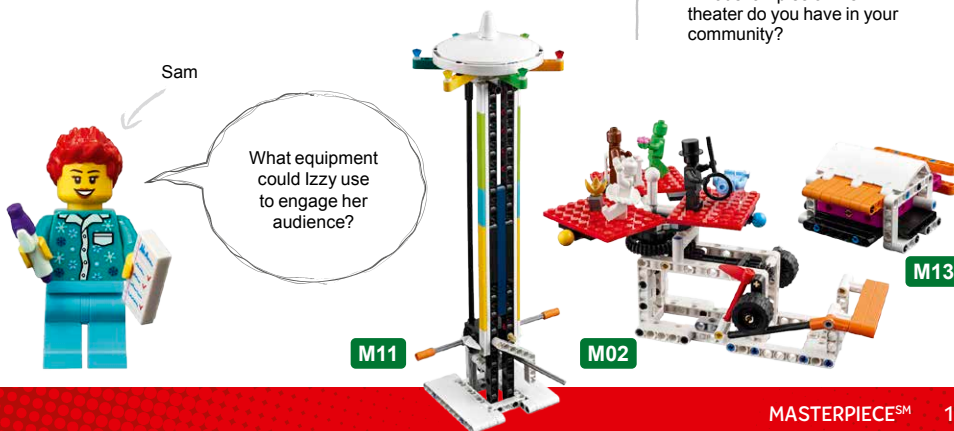
Session 4

Outcomes

The team will:
- Code their driving base to follow a line using the color sensor.
- Make connections from the mission models to the sound engineer Project Spark ideas.

1. Plug in the controller and open the app periodically to check for software and firmware updates.

2. Have the team choose lines on the mat that will help them navigate the robot to different missions.

3. Have the team follow the program on the screen to see how it matches the robot's actions. This will help them debug their programs.

4. Try to start the robot in the same or a very similar place each time in one of the launch areas.

5. Robot Game Connection: Have the team adapt and test out their line-following program on the mat.

➔ Introduction
(10-15 minutes)

☐ Think about how you have used the Core Value of **discovery** in your team's journey so far.

☐ Record examples of how your team has learned new skills and ideas.

➔ Tasks
(50-60 minutes)

1 ☐ Open the SPIKE™ Prime app. Find your lesson.

2
3 **Competition Ready Unit: Training Camp 3: Reacting to Lines**

4 ☐ Determine what building and coding skills will help you in the robot game.

☐ Try it out! See if you can use the skills you learned to complete another mission.

5

➔ Reflection Questions
- How did testing and debugging your program help make your robot more accurate?
- Can your robot follow the line from the left launch area to the sound mixer model?

Session 4

Discovery: We explore new skills and ideas.

Our Notes:

Sound Engineer

Have the team pick a few mission models to highlight and learn about them. Provide resources to the team to learn more about the real-world examples and problems the mission models represent and solve.

Sound Engineer

Project Spark

Sound engineers use mixers and other audio equipment to enhance a listening experience. Whether you're listening to your favorite artist sing a song or feeling the vibrations of a bass drum, sound can have a powerful impact.

10

Think about and research:
• What kind of projects could a sound engineer work on?
• How is sound used to change a listener's experience?
• What kind of training do you need to be a sound engineer?
• How is sound used in museums or films?

Our Ideas:

➜ Tasks
(50-60 minutes)

6 ☐ Read the Project Spark.

7 ☐ Build the Sound Engineer models in Bags 6 and 9.

8 ☐ Identify the missions that relate to the models you built.

☐ Discuss how the Project Spark and models are linked.

☐ Capture your ideas.

9

➜ Share
(10-15 minutes)

☐ Get together at the mat.

☐ Put each model where it belongs.

☐ Show how the models operate and their connection to the Project Spark.

☐ Show the robot skills you have learned.

☐ Discuss the reflection questions.

☐ Clean up your space.

➜ Reflection Questions

• How does a sound engineer record music and modify it to make instruments or vocals stand out?
• Where do concerts happen in your community?

6 Provide the digital building instructions for the models to the team.

7 The team will need Bags 6 and 9 from the Challenge set.

8 This is the last session for building models. Finish building all the models and place them on the mat before the next session.

9 The team may need extra time before moving on to the next session to finish building the mission models.

10 The Project Sparks presented in Sessions 1-4 provide different ideas for the team for their final innovation project.

How can sound help Izzy create a meaningful impact?

Noah

M06, M07

M10

Checkpoint 1

0   1   2   3

☐ The team has bonded and are working well together. If they need more support to achieve this, do some extra team-building activities.

☐ New teams may want to summarize the new robot skills they have learned.

☐ All models must be built and placed on the mat and secured with the Dual Lock squares as needed.

☐ Extra time can be spent on the robot lessons before moving on.

☐ Have students reflect on their goals and adjust them based on information they have learned in the first four sessions.

☐ The team has explored and designed solutions for all the Project Sparks.

☐ The team has reviewed the missions and rules in the *Robot Game Rulebook*.

☐ The team could complete the exploration activity listed in the Career Connections pages in the *Engineering Notebook* after Session 4.

☐ Check in with the team on their progress on their personal and team goals.

Sessions 5-8 Tips

CORE VALUES

Remember that the Core Values are about HOW the team behaves and works together. They should be demonstrated by all team members all the time.

ROBOT DESIGN

At the robot game matches, two robot game tables will be set up next to each other. However, during the sessions, you can work with a single robot game table.

INNOVATION PROJECT

The team will have to select a final problem and solution to focus on, so thinking about this goal during each session is helpful.

ROBOT GAME

Look for missions that:
• Use basic robot skills like push, pull, or lift.
• Have models close to a launch area.
• Involve navigation with line following.
• Have easy access to home.

Understanding the Rubrics
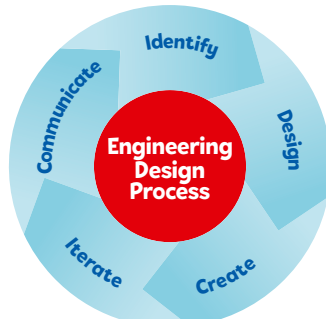

Core Values and *Gracious Professionalism*®

Teams express the six Core Values through the way they behave with each other and with people outside the team on their learning journey. In *FIRST*® LEGO® League Challenge, this is called *Gracious Professionalism*®.

Teams will have their *Gracious Professionalism* evaluated at every robot game match. Remember, if they cannot attend a match, they should let the referee know.

Innovation Project and Robot Design

The rubrics used to evaluate the teams in these areas are based on the engineering design process. The team works on their project

and robot and solves problems using this process. Team members need to demonstrate and explain everything they have done during the judging session.

Note: Class Packs may use the Class Pack rubric instead of these team rubrics.

Download Rubrics

Outcomes

The team will:
- Apply coding principles to the guided mission.
- Research solutions and identify their innovation project problem to solve. (Revisit page 6 of the *Engineering Notebook*.)

1 The team should be able to describe what everyone's strong points are and why they like working with them.

2 If the team is sharing one robot, they can code on individual devices and then take turns running their programs on the robot.

3 The provided program for the guided mission will not only solve the Theater Scene Change mission but will also be helpful to use on other missions.

4 Remind the team to test program changes in small steps instead of changing the entire program at once.

5 If an attachment is needed for a mission, keep it in a plastic bag labeled with the mission number.

➔ Introduction
(10-15 minutes)

1
- ☐ Think about **teamwork** and your team.
- ☐ Record examples of how your team has learned to work together.

➔ Tasks
(50-60 minutes)

2
- ☐ Open the SPIKE™ Prime app. Find your lesson.

Competition Ready Unit: Guided Mission

3
- ☐ Read over the guided mission.

4
- ☐ Have fun practicing this guided mission until it works perfectly!

5

➔ Reflection Questions
- What does the guided mission show you about *Coopertition®*?
- Can you change the program so that the mission works when you start the robot from the opposite launch area?

Teamwork: We are stronger when we work together.

Guided Mission: Mission 2 Theater Scene Change

To help you learn about navigating and interacting with a model, complete this guided mission.

In the app, download the program that solves this mission.

Start your robot in the correct position in the left launch area. Run your robot and watch it complete the mission and score the points.

Like all the mission models, Mission 2 Theater Scene Change might inspire you to think of a solution for your innovation project.

Think about how to incorporate the Theater Scene Change mission into your mission strategy.

Apply your new line-following skill to a different mission model.

Investigate Ideas

Facilitator Tips

Team-building activities are great for teams to develop, use their Core Values, and learn how to work together.

Investigate Ideas

Research Findings:

☐ Revisit Sessions 1-4 to review the Project Sparks.

6 ☐ Think about the great solutions you came up with in the previous sessions.

7 ☐ Research the innovation project and different problems you have identified.

☐ Use this page to capture your research.

8 ☐ Identify the problem your team will solve and record your

9 problem statement.

→ **Share**
(10-15 minutes)

☐ Get together at the mat.

☐ Show how your robot scores points on the guided mission.

☐ Discuss the problem your team has identified and think about next steps.

☐ Discuss the reflection questions.

☐ Clean up your space.

→ **Reflection Questions**

• What problem did you decide to solve?

• Is there an expert you can talk to about the problem?

10
Problem Statement:

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6 Encourage the team to record all problem ideas they have identified for the innovation project.

7 Project resource examples include the Internet, books, magazines, personal stories, user experiences, and experts (in person or virtual).

8 Each team member might not get their favorite problem chosen, but the team should choose something everyone supports.

9 The team can use a problem identified within one of the Project Sparks to develop their solution.

10 The team will write their final problem statement here. If they have multiple ideas, they could use a voting process to narrow it down to one.

Session 6

Outcomes

The team will:
- Create a mission strategy plan and write pseudocode for a mission.
- Conduct research on their identified problem and start the Innovation Project Planning page.

1 Building the experts in Bag 13 is a great time for the team to review what they learned about the Project Sparks.

2 Provide sticky notes and planning cards for the team to place on the mat to map out their mission strategy.

3 Encourage the team to find the missions where points can be scored most easily and do them first.

4 The Pseudocode page can be photocopied. It can be used for each mission the team attempts.

Pseudocode

Mission Name: Mission Number:

CODING STEPS
Write out the moves the robot should make to complete the mission.

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.

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.

Complete this page in Session 6.

22   Engineering Notebook | Sessions

Session 6

1 → **Introduction**
(10-15 minutes)
- ☐ Locate Bag 13 and assemble the expert minifigures.
- ☐ Work as a team to assemble the minifigures and discuss their jobs. Think about how these experts could help with your innovation project ideas.

→ **Tasks**
(50-60 minutes)
- ☐ Watch the "Robot Game Missions" video.
- **2** ☐ Start to think about your mission strategy.
- ☐ Design an effective plan.
- **3** ☐ Discuss which missions your team will attempt first.
- **4** ☐ Complete Pseudocode on page 22.
- ☐ Think about how the program will make your robot act.
- ☐ Revisit the earlier lessons or do the optional lesson listed here.

Competition Ready Unit: Assembling an Advanced Driving Base

→ **Reflection Questions**
- How could you use line following to help you navigate the mat?
- How did you use the engineering design process to create your mission strategy?

Innovation Project Model Design:

Strategy:

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

20   Engineering Notebook | Sessions

Identify Solutions

Provide extra paper or a shared online file for the team to capture the process used to create their robot and innovation project solutions. The team will be judged on their final robot and project solutions as well as the process they used.

Identify Solutions

PROBLEM AND SOLUTION ANALYSIS

Record important information here.

→ Tasks
(50-60 minutes)

5 Research the problem you chose and any existing solutions.

6 Generate solution ideas. Make a plan for how you will develop your solution. Use page 23, Innovation Project Planning, as a tool.

7 Be sure to use a variety of sources and keep track of them on the Innovation Project Planning page.

☐ Select your project's final solution as a team.

8

→ Share
(10-15 minutes)

☐ Get together at the mat.

☐ Review your Pseudocode page. Make changes to the page if necessary.

☐ Explain what you discovered in your research. Discuss any solution ideas.

☐ Discuss the reflection questions.

☐ Clean up your space.

→ Reflection Questions
• What types of improvements do existing solutions need?
• What are your brand-new ideas to solve the problem?

Guiding Questions:
• What questions are you trying to answer?
• What information are you looking for?
• Can you use different types of sources such as credible Internet websites, books, and experts?
• Does your source have information relevant to your project?
• Is this a good and accurate source of information?
• How do your innovation project plans connect with the innovation project rubric?

Izzy

5 Be sure the team collects their sources in a shared location, either online or on paper.

6 Take some extra time with the team if needed to explore all the solution ideas and narrow it down to one.

7 Make sure their solution has the potential to be developed and they can explain their solution clearly.

8 The Innovation Project Planning page can be completed over multiple sessions and helps the team document their process.

Innovation Project Planning

PROCESS
Describe the process you followed to develop your innovative solution.

SOURCES
Write down where you got your information. Include details such as the title, author, and website.
1.
2.
3.

Complete this page in Session 6.

MASTERPIECE℠   23

Session 7

Outcomes

The team will:
- Create their innovation project solution and complete the Innovation Project Planning page.
- Design and iterate on their robot to complete additional robot game missions.

1 Check the team knows the Core Values and understands what *Gracious Professionalism®* is.

2 Different members of the team can be responsible for specific missions and develop and own the robot run for those missions.

3 When the team has a base robot, do a straight drive test. If it doesn't go straight, look at the robot's center of gravity and balance.

4 Have the team determine which launch area will be the starting position and make sure there is enough room for the whole robot to fit inside the launch area.

5 Encourage the students to explain the program as the robot moves.

→ Introduction
(10-15 minutes)

1
- ☐ Think about *Gracious Professionalism®*.
- ☐ Write ways your team will demonstrate this in everything you do.
- ☐ Look over page 6 in the *Robot Game Rulebook* to see how *Gracious Professionalism* is evaluated during the tournament.

→ Tasks
(50-60 minutes)

2
- ☐ Continue to develop your robot and its attachments to complete missions in the robot game.

3
- ☐ You can improve the existing robot used in the previous sessions or create a new design.

4
- ☐ Create a program for each new mission you attempt. You could combine mission solutions into one program.

5
- ☐ Test and improve your robot and its programs.
- ☐ Revisit previous lessons to develop your coding skills or work on solving the missions.

→ Reflection Questions
- Can you follow how the program on your device is making your robot move?
- How can you iterate and improve on the existing robot design used in previous sessions?

Session 7

> *Gracious Professionalism*: We show high-quality work, highlight the value of others, and respect individuals and the community.

Robot Design:

You could modify the existing robot you've used in past sessions.

Create Solutions

Facilitator Tips

By embracing the Core Values, the team learns that friendly competition and mutual gain are not separate goals and that helping one another is the foundation of teamwork.

Create Solutions

PROJECT DRAWING

PROJECT DESCRIPTION

➜ Tasks
(50-60 minutes)

6 ☐ Develop and create your innovation project solution.

7 ☐ Sketch your solution. Label the parts and how it will work.

8 ☐ Describe your solution and explain how it solves the problem.

9 ☐ Create a prototype, model, or drawing of your solution.

10 ☐ Document the process you use to develop your solution on page 23, Innovation Project Planning.

➜ Share
(10-15 minutes)

☐ Get together at the mat.

☐ Show any missions you are working on or have completed.

☐ Discuss your research and your innovation project solution.

☐ Discuss the reflection questions.

☐ Clean up your space.

➜ Reflection Questions

• Can you describe your innovative solution in under five minutes?

• How does your solution address your identified problem?

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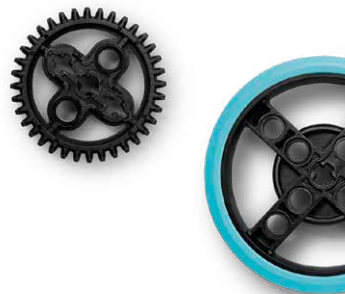
6 Provide a variety of materials for the team to use to make a prototype of their project solution.

7 A drawing can include a detailed annotated sketch or a computer-aided design (CAD) drawing.

8 Have the team think of people (audience or experts) they would like to get feedback from on their solution.

9 Arrange a visit to look at examples in your community that can be a focus of the project.

10 Consider inviting an expert or user to this session to share content about their identified problem.

Session 8

Outcomes

The team will:
- Evaluate and improve on their innovation project solution.
- Design robot attachments and create programs to solve missions.

1 Have the team discuss how the guided mission is an example of *Coopertition®*.

2 The team should think about strategy when choosing missions to solve. Multiple missions can be completed on the same run to save time.

3 Encourage the team to discuss how their program works. Break the program into blocks that control one movement.

4 Treat the robot game like a sport. The team needs to practice, practice, practice to perform well in the robot game.

5 Where the robot starts in a launch area strongly influences where it ends. Have the team keep good notes about where the robot is placed.

---

1 → **Introduction**
(10-15 minutes)
- ☐ Reflect on *Coopertition®*.
- ☐ Note ways your team will demonstrate this at an event.

→ **Tasks**
(50-60 minutes)
2 ☐ Decide which mission to attempt next.
3 ☐ Think about your mission strategy and plan.
☐ Build any attachments you need to complete missions.
4 ☐ Iterate and refine your program so your robot completes the mission reliably.
5 ☐ Be sure to document your design process and testing for each mission!

→ **Reflection Questions**
- How has your team used Core Values to develop your robot solution?
- In what order will you run the missions in the robot game?

Session 8

Coopertition: We show that learning is more important than winning. We help others even as we compete.

Design Process:

Guiding Questions:
- Describe the attachments you built.
- Explain your different programs and what the robot will do.
- How did you test your programs and attachments?
- What changes did you make to your robot and programs?
- How does your robot plan connect with the robot design rubric?

Continue Creating

Use the Core Values where appropriate to encourage the team. To celebrate the team learning these important values, highlight examples of when the team demonstrates these principles.

Continue Creating

Plan to Share:

Our Improvements:

→ Tasks
(50-60 minutes)

6 ☐ Make a plan to share about your solution with others!

☐ Evaluate your present solution.

7 ☐ Iterate and improve to make it better based on feedback.

8 ☐ Determine if you can do any testing of your solution.

9

→ Share
(10-15 minutes)

☐ Get together at the mat.

☐ Show any missions you are working on or have completed.

☐ Discuss how you will share your solution and project plan with others.

☐ Discuss the reflection questions.

☐ Clean up your space.

10

→ Reflection Questions

• How can you realistically implement your innovation project solution?

• Could your innovation project solution be manufactured? What would it cost?

6 The team can create a survey to evaluate their solution or ask for feedback from someone who is an expert or user for their chosen problem.

7 The team should iterate and improve their innovation project solution following feedback from others.

8 The team should think about how they use innovation to help solve problems they encounter.

9 The team should reference the rubrics so they can be prepared for judging at the event.

10 The team could go through multiple cycles of the engineering design process as they test and improve their innovation project solution.

Why is it important that a sound engineer ensures their work is reliable and correct?

Checkpoint 2

0 — 1 — 2 — 3

- [ ] The team has completed all the robot lessons outlined in the sessions.
- [ ] The team has selected an innovation project problem and solution and has conducted research.
- [ ] Visit the *FIRST®* LEGO® League Challenge Season Resource page to print copies of the team rubrics (Core Values, innovation project, and robot design) and any other information that will help prepare for your event.

- [ ] Provide the team with the judging flowchart and judging rubrics.
- [ ] If you are implementing a Class Pack, you can make copies of the Class Pack rubric from the *Class Pack Event Guide*.
- [ ] The team could complete the Career Connections exploration activity after Session 9 and the reflection activity after Session 12. These activities are found on pages 34-35 in the *Engineering Notebook*.

Sessions 9-12 Tips

CORE VALUES

Make sure the team can provide concrete examples of the Core Values they use. Don't forget *Coopertition®* and *Gracious Professionalism®*.

ROBOT DESIGN

The team should bring their robot, all the LEGO® attachments, and their computer or program printouts to their judging session when they provide their explanation to the judges. Remind the team to include their mission strategy.

INNOVATION PROJECT

The team will need plenty of time to iterate, improve, and build a model or prototype of their idea. From Session 9 on, they should focus only on progress toward their final innovation project solution.

ROBOT GAME

The team needs a well-practiced and reliable robot run that they know will score them points. If they have time, they can have additional runs to score more points.

Session 9
Solution Planning
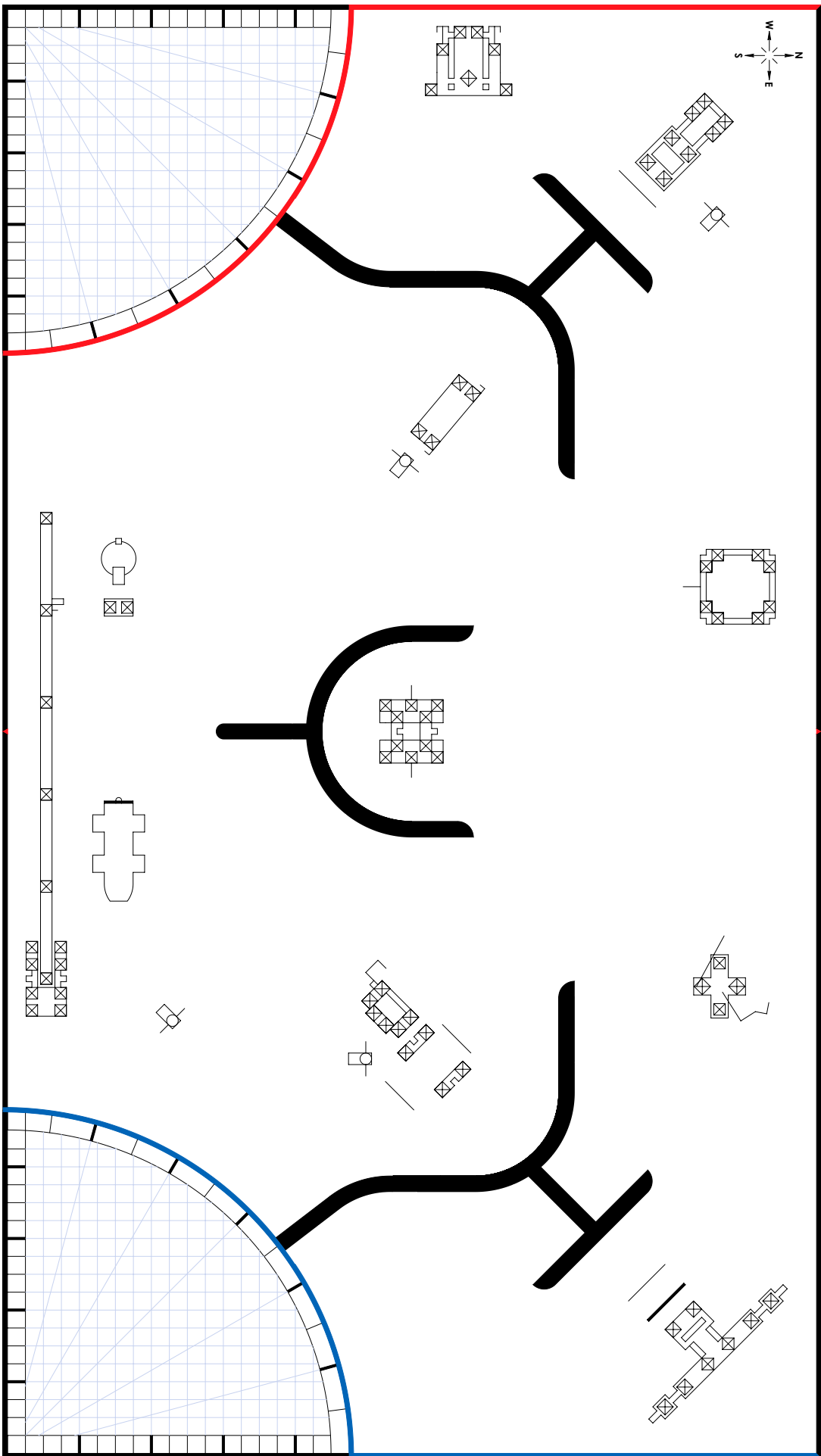
Outcomes

The team will:
- Code their robot to deliver their innovation project model and solve missions.
- Iterate and improve their innovation project solution based on testing and feedback.

1. The team will use their art piece and pedestal in Mission 04 of the robot game.

2. The team can also have a backup of their programs on external drive like a USB stick or an online storage website.

3. Have a clear strategy for which programs to run and in what order during the robot game.

4. The Share tasks are important to keep the whole team updated on how the project and the robot are developing.

5. Provide the team with the Core Values rubric.

→ Introduction
(10-15 minutes)

- ☐ Think about **innovation** and your team.
- ☐ Record examples of how your team has been creative and solved problems.
- **1** ☐ Use the bricks in Bag 4 to build your team's LEGO® art piece.

→ Tasks
(100-120 minutes)

- ☐ Code your robot to complete Mission 04 using the art piece you created.
- **2** ☐ Think about your mission strategy on the mat and the missions you will solve.
- **3** ☐ Continue to create a solution for each mission as time allows.
- ☐ Test, iterate, and improve your robot and innovation project solutions. Be sure to document all this.

→ Share
(10-15 minutes)

- **4** ☐ Get together at the mat.
- ☐ Show the work completed on the innovation project and robot game.
- **5** ☐ Look over the Core Values rubric. Talk about how you will demonstrate Core Values at the event and judging session.
- ☐ Clean up your space.

→ Reflection Questions
- What features on your robot show good mechanics?
- What changes have you made to your innovation project solution based on feedback from others?
- What progress have you made on the goals set in Session 2?

Session 9 — Solution Planning

Innovation: We use creativity and persistence to solve problems.

Iterations and Improvements:

How does a stage manager use teamwork on the job?

Outcomes

The team will:
- Plan and create their innovation project presentation, where they will pitch their solution.
- Continue to solve missions for the robot game.

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

Presentation Script:

➜ Introduction
(10-15 minutes)

☐ Think about **impact** and your team.

☐ Record examples of how your team has had a positive influence on you and others.

➜ Tasks
(100-120 minutes)

1 ☐ Plan out your project presentation. Refer to the innovation project rubric for what to cover.

2 ☐ Write out your innovation project presentation script.

3 ☐ Make any props or displays that you need. Be engaging and creative!

☐ Continue to create, test, and iterate on your robot solution.

4 ☐ Practice a 2.5-minute robot game with all your completed missions.

➜ Share
(10-15 minutes)

☐ Get together at the mat.

5 ☐ Share the project presentation work completed.

☐ Share what missions you have completed.

☐ Discuss how everyone will be involved in the presentation.

☐ Discuss the reflection questions and clean up your space.

➜ Reflection Questions
- How did you decide which missions to attempt?
- How can your innovation project solution help your community?
- What skills have you developed throughout your MASTERPIECE℠ experience?

How will your innovation project solution have an impact on others?

1 Their presentation can be a slideshow, poster, play, or even a skit. Props can be used, such as costumes, shirts, or hats.

2 Scripts can be made for the judging session when the team presents their innovation project and robot solutions. Provide copies for each team member.

3 The team might need more space to store all their materials for the presentation.

4 Encourage the team to run their robot in practice 2.5-minute robot matches so that they get used to the time limit.

5 Provide the team with the innovation project rubric.

Session 11

Presentation Planning

Outcomes

The team will:
- Finalize their live innovation project presentation.
- Finalize their robot for the robot game and prepare their robot design explanation.

1 Have the team review the rubrics for examples of where inclusion is evaluated.

2 It's important for the team to practice how to communicate their innovation project and robot design solutions.

3 Provide the team with the robot design rubric.

4 Every team member should be involved in the presentation at the judging session.

5 The team should know who will run the robot during the matches.

---

1 → **Introduction**
(10-15 minutes)
- ☐ Think about **inclusion** and your team.
- ☐ Record examples of how your team makes sure everyone is respected and their voices are heard.

→ **Tasks**
(100-120 minutes)
2 ☐ Continue working on your innovation project presentation.
3 ☐ Plan and write out your robot design presentation. Refer to the robot design rubric for what to cover.
4 ☐ Make sure everyone can communicate about your design process and programs.
- ☐ Determine what each person on the team will say.
- ☐ Practice your full presentation.

→ **Share**
(10-15 minutes)
- ☐ Get together at the mat.
- ☐ Discuss the presentation and each person's role.
5 ☐ Run a practice 2.5-minute match and explain what missions were done.
- ☐ Discuss the reflection questions.
- ☐ Decide what else needs to be done and clean up your space.

→ **Reflection Questions**
- What will you do if one mission does not work?
- How is everyone involved in the presentation?
- How has *FIRST*® LEGO® League impacted you?

Session 11 — Presentation Planning
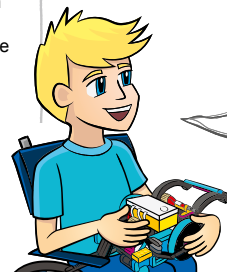
Inclusion: We respect each other and embrace our differences.

Presentation Script:

Review the judging session flowchart to see how you will present your robot design and innovation project.

Session 12 — Communicate Solutions

Outcomes

The team will:
- Practice their presentation of their innovation project and robot solutions.
- Run practice robot game matches.

Session 12 — Communicate Solutions

Fun: We enjoy and celebrate what we do!

Presentation Feedback:

→ Introduction
(10 minutes)

☐ Reflect on how your team has had **fun**.

☐ Record examples of how your team has had fun throughout this experience.

☐ Think about your team's goals. Did you meet them?

→ Tasks
(100 minutes)

1 ☐ Rehearse your full presentation communicating your robot and innovation project solutions.

2 ☐ Demonstrate Core Values when you present!

3 ☐ Practice multiple 2.5-minute robot game matches.

4 ☐ Review pages 32-33, Prepare for Your Event.

→ Share
(10 minutes)

5 ☐ Review the Core Values, innovation project, and robot game rubrics.

☐ Provide helpful feedback after the presentation to each other based on the rubrics.

☐ Discuss the reflection questions.

☐ Clean up your space.

→ Reflection Questions
- What is your plan for having any LEGO® attachments built ready for the robot game?
- Is everyone ready to speak clearly, smile, and have fun?
- What has your team accomplished?

Have more time? Continue solving missions and working on your innovation project before your event!

1 Plan to split the time in this session equally between practicing the presentation and the robot game matches.

2 Encourage the team to practice their presentation before the event. They can practice by sharing their solution with others.

3 Have the team run their 2.5-minute robot matches. Make sure they practice running their programs in the right order.

4 The team should have a contingency plan for if things don't go as planned during the robot game. They could identify other missions to run.

5 Remind the team about the Core Values and how they will show them throughout the event, including at every robot game match.

Final Checkpoint

0 — 1 — 2 — 3

Prepare for Your Tournament!

☐ The main goal of an event is for the team to have FUN and to feel that their work is valued.

☐ Remind the team that the event is also a learning experience and the goal is not to be an expert when they arrive.

☐ Encourage the team to engage with other teams to share what they have learned and to support each other.

☐ Check over the details and requirements for the tournament you are attending. They can vary depending on the type you plan to attend.

☐ Review the time and location where you are meeting for the event and how long the team is expected to stay – share this with parents. Encourage families to attend if possible.

☐ Have the team prepare a checklist of materials that are needed for the event and where they will be stored.

☐ Determine what type of event you're attending and who the organizer of your event is. (If you purchased a Class Pack, the event will be your responsibility. Check out the *Class Pack Event Guide* for more details!)

☐ Reflect with the team on their personal and team goals and their accomplishments.

Beyond *FIRST* LEGO® League?

Connect with a *FIRST* Tech Challenge or *FIRST* Robotics Competition team so that your Challenge team can see how they can continue their *FIRST* experience in the future.

FIRST TECH CHALLENGE

FIRST ROBOTICS COMPETITION
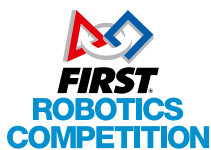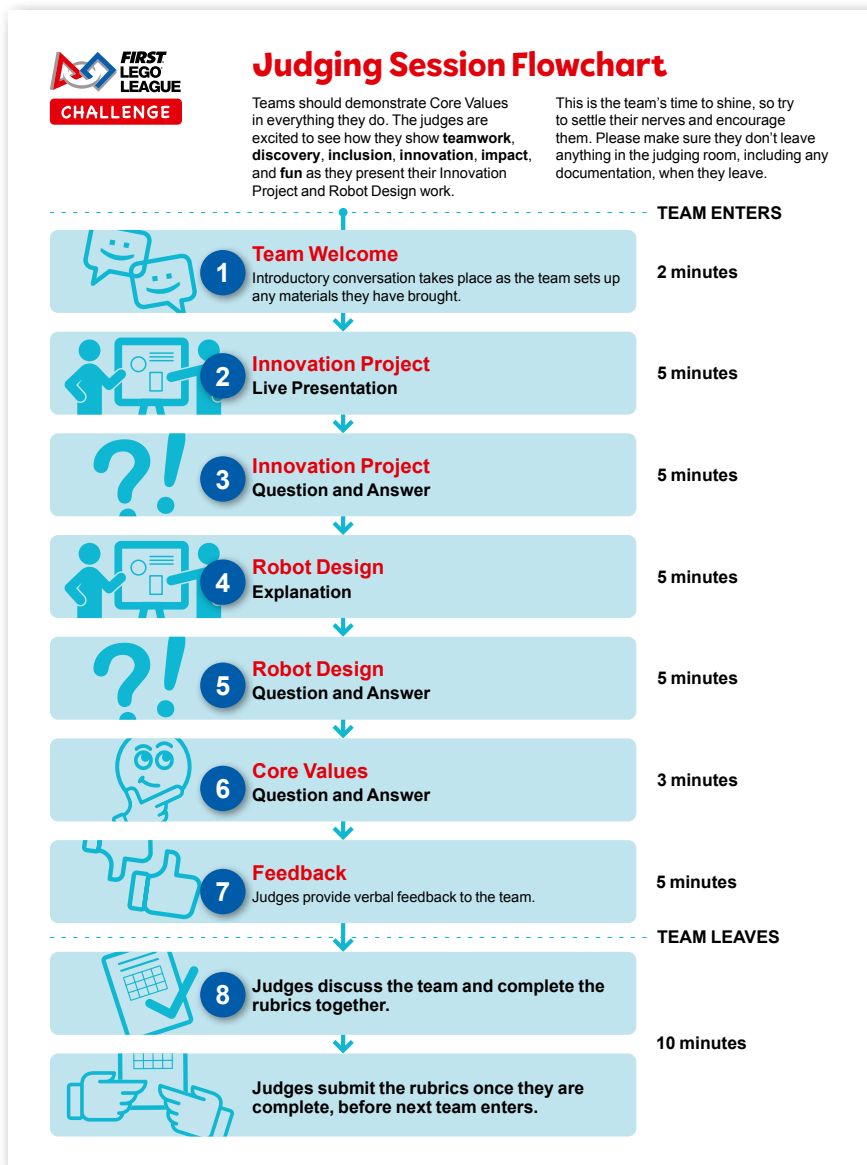
Judging and Event Resources

Events Complete and All Done?

Here are some tips for wrapping up after your team's last event:

• Clean up and take apart the robot and mission models.

• Allow time for the team to reflect on their experience.

• Inventory the LEGO® set to make sure all the pieces are there.

• Hold a team celebration!

• Have the team share their experience with friends and classmates.

• Have the team continue developing their innovation project.

• Discuss your rubric scores and feedback received.

Understanding Judging

Judging Session Flowchart

Teams should demonstrate Core Values in everything they do. The judges are excited to see how they show **teamwork**, **discovery**, **inclusion**, **innovation**, **impact**, and **fun** as they present their Innovation Project and Robot Design work.

This is the team's time to shine, so try to settle their nerves and encourage them. Please make sure they don't leave anything in the judging room, including any documentation, when they leave.

TEAM ENTERS

1 **Team Welcome**
Introductory conversation takes place as the team sets up any materials they have brought.
2 minutes

2 **Innovation Project**
Live Presentation
5 minutes

3 **Innovation Project**
Question and Answer
5 minutes

4 **Robot Design**
Explanation
5 minutes

5 **Robot Design**
Question and Answer
5 minutes

6 **Core Values**
Question and Answer
3 minutes

7 **Feedback**
Judges provide verbal feedback to the team.
5 minutes

TEAM LEAVES

8 Judges discuss the team and complete the rubrics together.

Judges submit the rubrics once they are complete, before next team enters.
10 minutes

1 During setup, the judges will ask questions to find out about the team and what experience they have in the program.

2 The team can present their innovation project uninterrupted by the judges.

3 Judges use the rubric to find out more about the innovation project solution and anything the team did not make clear during their presentation.

4 Judges listen as the team explains how they worked on the robot and demonstrate their understanding of their programs.

5 Judges use the rubric to find out the depth of the team's understanding of the robotics and coding.

6 The Core Values are evaluated throughout the judging session, but this reflection section is for the judges to ask additional questions.

7 To inspire the teams, the judges give immediate verbal feedback on what the team did well but also on where further work would improve their performance.

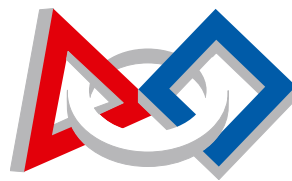**8** After the team leaves, the judges work together to complete and submit the rubrics.

If there is too much information for the team to cover in detail, visual aids can be very useful references. Make sure the team practices how they will use them in the judging session.

FIRST IN SHOW

PRESENTED BY Qualcomm

FIRST LEGO LEAGUE