Introduction to *FIRST* LEGO League Challenge

MASTERPIECE SM

FIRST LEGO LEAGUE CHALLENGE

“I don’t use kids to build robots. I use robots to build kids”

- Dean Kamen

FIRST IN SHOW
PRESENTED BY Qualcomm

MASTER PIECE

CENTER STAGE
PRESENTED BY Raytheon Technologies

CRESCENDO
PRESENTED BY HAAS

Three *FIRST* Programs (K-12)

FIRST LEGO League: Discover, Explore, Challenge

FIRST Tech Challenge

FIRST Robotics Competition

Table of Contents

Team

- Generally, children, ages 9 to 14, (grades 4-8) are eligible to participate in North America
- Elsewhere, ages 9-16
- Check with local organizers for exceptions
- Teams consists of 2 (minimum) - 10 (maximum) students
- Two official adult coaches with clearances per team
- Youth and adult mentors are allowed, but kids on the team do the work

Approximate Timeline

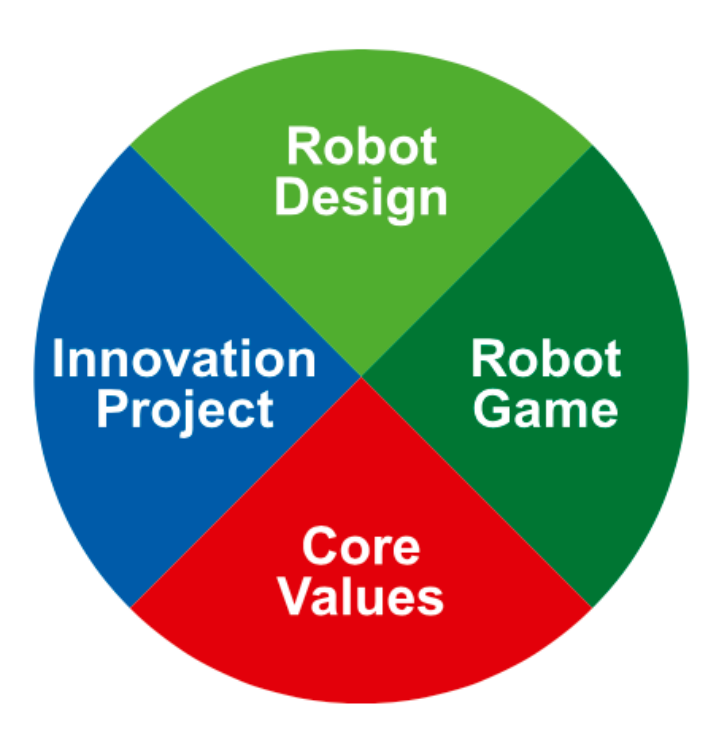
August 2, 2022: Challenge documents released
August-November 2022: Team meets weekly to solve the challenge
November-December 2022: Qualifiers
December 2022 -January 2023: State/Regional Championship
April 2023: World Championships
May 2023: Open Invitationals

Timelines vary by region. Contact your local organizers for more contest dates.

Team Costs

- Robot/Equipment - approx. $500.00 per robot (2 per team is useful)
  - SPIKE Prime, MINDSTORMS EV3, MINDSTORMS Robot Inventor
  - You can purchase from FIRST via you Dashboard or directly from LEGO Education
  - Cost includes a Core Set + Expansion Set
- Wooden Robotics Table - approx $100.00
- National Team Registration - $225
- LEGO Challenge Set - $75
- Local Tournament Registration - $75-$250+ (varies greatly by region)
- Travel Expenses
- Shirts/Supplies

Four Parts of *FIRST* LEGO League Challenge



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

Core Values

What are Core Values?

- The cornerstones of the program.
- They are among the fundamental elements that distinguish *FIRST* from other programs of its kind.
- The set of ideas that every FIRST team should live by:
  - Work with others in a respectful way
  - Impact the community in a positive way

What is Gracious Professionalism and Coopertition?

Gracious Professionalism:

- High-quality work, emphasis on the value of others
- Respect for individuals and the community.
- Competition and mutual gain are not separate notions.

Coopertition:

- The idea you should respect and support teams you compete against.

Core Values Rubric

The rubric addresses the major elements that teams are judged on and how overall Core Values skills are evaluated

- Students will give examples to demonstrate their understanding and use of each of the Core Values.

BEGINNING Minimally observed across the team. 1	**DEVELOPING** Inconsistently observed across the team. 2	**ACCOMPLISHED** Consistently observed across the team. 3	**EXCEEDS** 4	*How has the team exceeded?*
DISCOVERY – Team explored new skills and ideas.				
☐	☐	☐	☐	
INNOVATION – Team used creativity and persistence to solve problems.				
☐	☐	☐	☐	
IMPACT – Team applied what they learned to improve their world.				
☐	☐	☐	☐	
INCLUSION – Team demonstrated respect and embraced their differences.				
☐	☐	☐	☐	
TEAMWORK – Team clearly showed they had worked as a team throughout their journey.				
☐	☐	☐	☐	
FUN – Teams clearly had fun and celebrated what they have achieved.				
☐	☐	☐	☐	

Create a Team Identity/Have Fun

- Team Identity is a huge part of being a FIRST team.
- Many teams choose to express themselves with hats and team t-shirts.
- Helps your team stand out in a crowd
- Gives a team a sense of personality and individuality.

Spread STEM in the Community

FIRST is all about sharing your knowledge of STEM within the community:

- Reaching out with other teams,
- other students,
- or anyone with an interest in STEM

A great way to get others involved and further build your program:

- Events
- Team Workshops
- Online Mentorship

Help Other Teams

Helping out others can do worlds of good within the FIRST community.

- Help others, even if you have to compete against one another
- Help if you see a team struggle with a mission
- Lend parts if you have a missing piece that they do not have

Sharing your knowledge and resources can build bonds with others and spread success on a greater level.

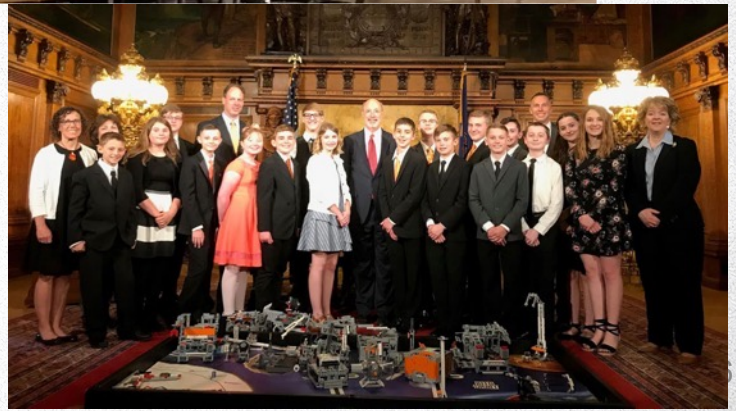
Learn to Communicate

Communication is key when it comes to being a successful team.

- Communicate with your own team so you can learn from each other
- Communicate with others on and off the field

Teams build communication skills so that they can speak to the media and even the Governor of Pennsylvania

- Helps spread the importance of STEM in the community



Core Values Judging

Judges make evaluations of a team based on the the rubric.

- Looking to see if a team understands each of the Core Values and has implemented them on their team

Judges are looking to reward well-rounded team where…

- Everyone has a role to play
- Everyone is treated with respect
- Students have understood FIRST and applied in their daily lives and community

Learn to Work Together as a Team

- Help team members get to know each other
- Make sure everyone is involved
- Help to learn to problem solve in a large group
- Help to learn to reach a consensus when there are different ideas

Doing a Teamwork Activity during team practices allows everyone's voice to be heard and can prepare a team when it comes time where there is a real challenge at hand.

Learning Life Skills through FIRST

- Teamwork
- Communication
- Problem Solving
- Helping one another
- Giving back to community

Events

- Fun and exciting
- Meet teams from different places
- People who share similar interests with you
- Everyone at events is very willing to help
- Learn from each other
- Get feedback from judges and improve your work

Robot Game

Overview

- 4ft x 8ft table with a mat
- All mission models are LEGO-based
- LEGO MINDSTORMS or SPIKE Prime
- Yearly theme:
  - 2023 – MASTERPIECE
  - 2022 - Super Powered
  - 2021 - Cargo Connect
  - 2020 - RePLAY
  - 2019 - City Shaper
  - 2018 - Into Orbit

Robot Runs

- Robot Competition: 3 rounds, top score qualifies
- Each team has 2.5 minutes to complete as many challenges as they can
- Each mission on the board is worth a different number of points
  - Harder missions are not always worth more points
- Each mission has its own set of rules and instructions
- Referees score you at the end of each run

2023-24 Season

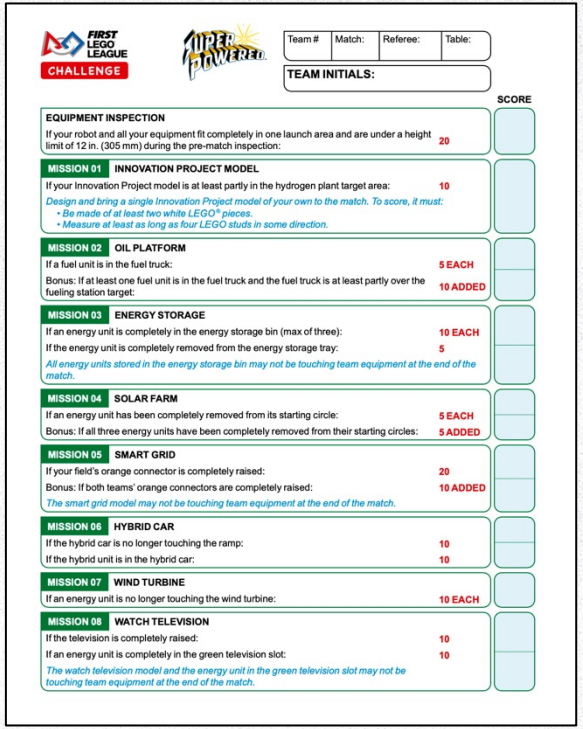
- Arts-based theme
- Lines are provided to allow the robot to line follow
- Missions are based on real-world scenarios related to the Arts

Challenges Teams Face

- Building an efficient and sturdy robot
  - LEGO Technic is often new material for teams
  - Learning to use the right elements
  - Learning to build compactly
  - Teams are often tempted to copy robots from online, but we encourage creativity
- Navigating to the correct location requires teams to think about how to use sensors
  - Sensors are often “scary” for young teams
- Teams struggle with reliability
  - Robot does not behave the same day-to-day or at event

Robot Missions

- Typically 15 missions every year
- Teams pick and choose based on their experience and ability
- FIRST provides the solution to one mission every year to get rookies started
- Rookies are expected to complete 2-3 mission reliably
- Veteran teams will complete more
- A few high-end teams will aim to complete *all* the missions



FIRST LEGO League CHALLENGE — SUPERPOWERED

Team # | Match: | Referee: | Table:

TEAM INITIALS:

SCORE

EQUIPMENT INSPECTION
If your robot and all your equipment fit completely in one launch area and are under a height limit of 12 in. (305 mm) during the pre-match inspection: 20

MISSION 01 INNOVATION PROJECT MODEL
If your Innovation Project model is at least partly in the hydrogen plant target area: 10
Design and bring a single Innovation Project model of your own to the match. To score, it must:
- *Be made of at least two white LEGO® pieces.*
- *Measure at least as long as four LEGO studs in some direction.*

MISSION 02 OIL PLATFORM
If a fuel unit is in the fuel truck: 5 EACH
Bonus: If at least one fuel unit is in the fuel truck and the fuel truck is at least partly over the fueling station target: 10 ADDED

MISSION 03 ENERGY STORAGE
If an energy unit is completely in the energy storage bin (max of three): 10 EACH
If the energy unit is completely removed from the energy storage tray: 5
All energy units stored in the energy storage bin may not be touching team equipment at the end of the match.

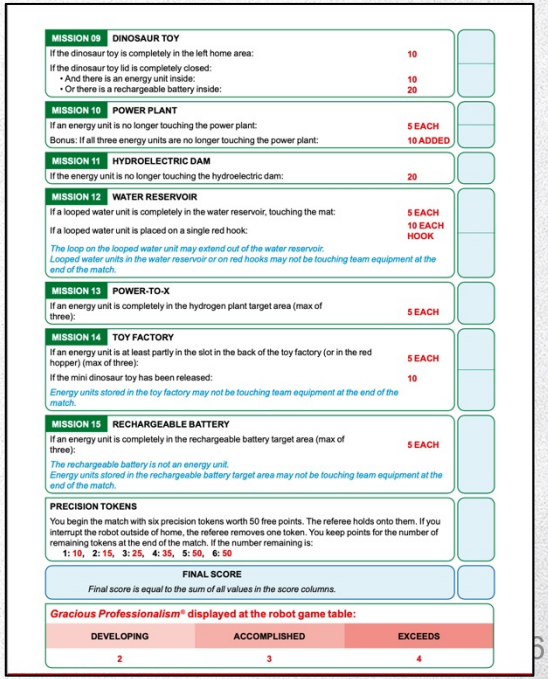
MISSION 04 SOLAR FARM
If an energy unit has been completely removed from its starting circle: 5 EACH
Bonus: If all three energy units have been completely removed from their starting circles: 5 ADDED

MISSION 05 SMART GRID
If your field's orange connector is completely raised: 20
Bonus: If both teams' orange connectors are completely raised: 10 ADDED
The smart grid model may not be touching team equipment at the end of the match.

MISSION 06 HYBRID CAR
If the hybrid car is no longer touching the ramp: 10
If the hybrid unit is in the hybrid car: 10

MISSION 07 WIND TURBINE
If an energy unit is no longer touching the wind turbine: 10 EACH

MISSION 08 WATCH TELEVISION
If the television is completely raised: 10
If an energy unit is completely in the green television slot: 10
The watch television model and the energy unit in the green television slot may not be touching team equipment at the end of the match.



MISSION 09 DINOSAUR TOY
If the dinosaur toy is completely in the left home area: 10
If the dinosaur toy lid is completely closed:
- And there is an energy unit inside: 10
- Or there is a rechargeable battery inside: 20

MISSION 10 POWER PLANT
If an energy unit is no longer touching the power plant: 5 EACH
Bonus: If all three energy units are no longer touching the power plant: 10 ADDED

MISSION 11 HYDROELECTRIC DAM
If the energy unit is no longer touching the hydroelectric dam: 20

MISSION 12 WATER RESERVOIR
If a looped water unit is completely in the water reservoir, touching the mat: 5 EACH
If a looped water unit is placed on a single red hook: 10 EACH HOOK
The loop on the looped water unit may extend out of the water reservoir.
Looped water units in the water reservoir or on red hooks may not be touching team equipment at the end of the match.

MISSION 13 POWER-TO-X
If an energy unit is completely in the hydrogen plant target area (max of three): 5 EACH

MISSION 14 TOY FACTORY
If an energy unit is at least partly in the slot in the back of the toy factory (or in the red hopper) (max of three): 5 EACH
If the mini dinosaur toy has been released: 10
Energy units stored in the toy factory may not be touching team equipment at the end of the match.

MISSION 15 RECHARGEABLE BATTERY
If an energy unit is completely in the rechargeable battery target area (max of three): 5 EACH
The rechargeable battery is not an energy unit.
Energy units stored in the rechargeable battery target area may not be touching team equipment at the end of the match.

PRECISION TOKENS
You begin the match with six precision tokens worth 50 free points. The referee holds onto them. If you interrupt the robot outside of home, the referee removes one token. You keep points for the number of remaining tokens at the end of the match. If the number remaining is:
1: 10, 2: 15, 3: 25, 4: 35, 5: 50, 6: 50

FINAL SCORE
Final score is equal to the sum of all values in the score columns.

***Gracious Professionalism*® displayed at the robot game table:**

DEVELOPING	ACCOMPLISHED	EXCEEDS
2	3	4

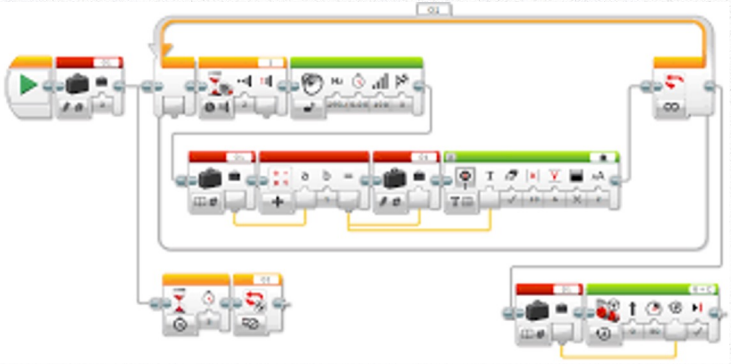
Robot Design

Types of Programming

EV3:

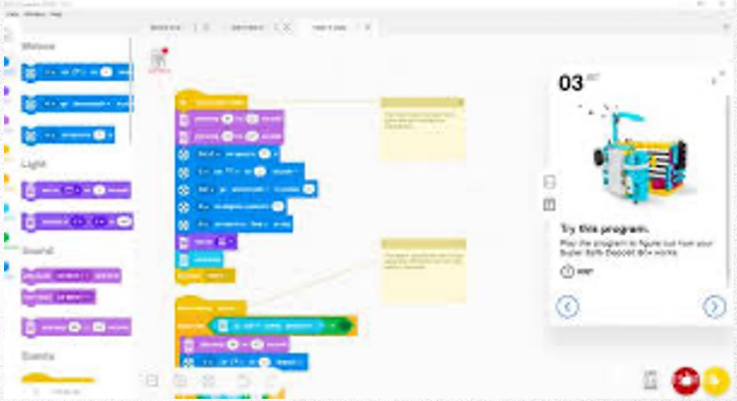
Block-based or Scratch-based

- Less condensed approach



SPIKE Prime:

- Scratch or Micro Python
- Linear approach



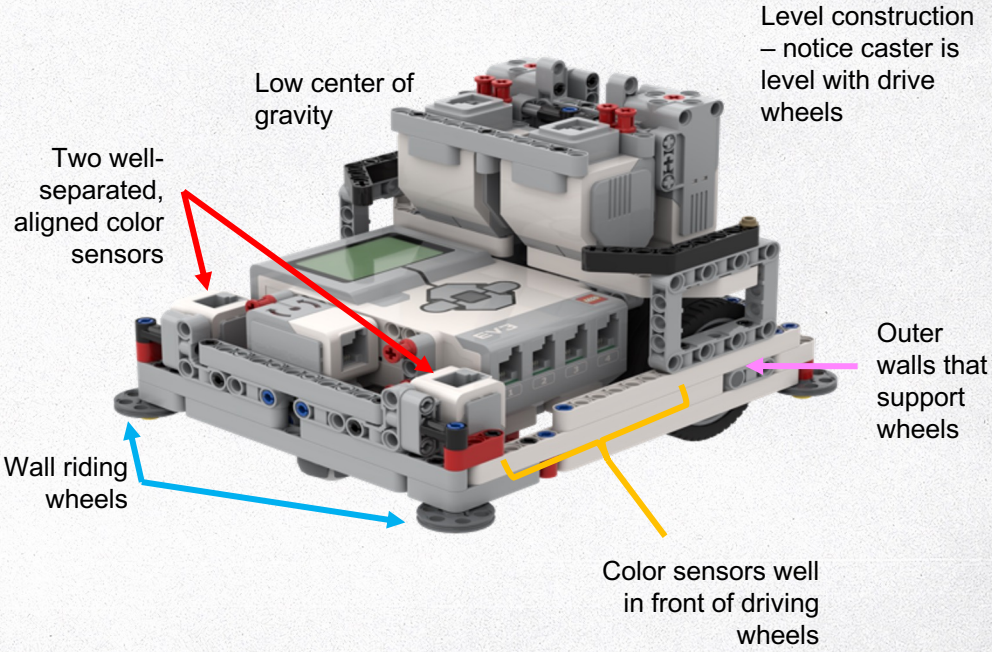
Programming Concepts to Learn Through FIRST

- Basic skills
  - Basic sensor usage, loops, switches, basic line following
- Intermediate skills
  - Custom MyBlocks, decision/logic blocks
- Advanced skills
  - Proportional control, PID line follower, gyro sensor usage, menu system

Figure 1

Engineering Concepts you Learn Through FIRST

- Students learn physics and engineering concepts when designing a robot
- Some teams CAD their LEGO robots



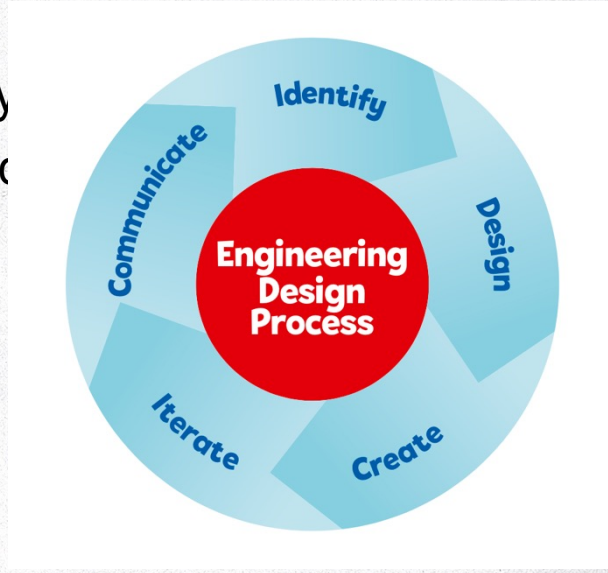
Robot Design Rubric

- How the team identifies what they need to do and how they do it
- Overall design of their robot
- What the team has created
- How the team tested their creations
- How well the team communicates how they've done in each of the other areas.
- Focus on all team members programming and building
- Team members test and document process

BEGINNING 1	DEVELOPING 2	ACCOMPLISHED 3	EXCEEDS 4 *How has the team exceeded?*
IDENTIFY – Team had a clearly defined mission strategy and explored building and coding skills they needed.			
☐ Unclear mission strategy	☐ Partially clear mission strategy	☐ Clear mission strategy	☐
☐ Limited evidence of building and coding skills in all team members	☐ Inconsistent evidence of building and coding skills in all team members	☐ Consistent evidence of building and coding skills in all team members	☐
DESIGN – Team produced innovative designs and a clear workplan, seeking guidance as needed.			
☐ Minimal evidence of an effective plan	☐ Partial evidence of an effective plan	☐ Clear evidence of an effective plan	☐
☐ Minimal explanation of robot and code's innovative features	☐ Partial explanation of robot and code's innovative features	☐ Clear explanation of robot and code's innovative features	☐
CREATE – Team developed an effective robot and code solution matching their mission strategy.			
☐ Limited explanation of their robot and its attachment and sensor functionality	☐ Simple explanation of their robot and its attachment and sensor functionality	☐ Detailed explanation of their robot and its attachment and sensor functionality	☐
☐ Unclear explanation of how code makes their robot act	☐ Partially clear explanation of how code makes their robot act	☐ Clear explanation of how code makes their robot act	☐
ITERATE – Team repeatedly tested their robot and code to identify areas for improvement and incorporated the findings into their current solution.			
☐ Minimal evidence of testing their robot and code	☐ Partial evidence of testing their robot and code	☐ Clear evidence of testing their robot and code	☐
☐ Minimal evidence their robot and code was improved	☐ Partial evidence their robot and code was improved	☐ Clear evidence their robot and code was improved	☐
COMMUNICATE – Team's explanation of the robot design process was effective and showed how all team members have been involved.			
☐ Unclear explanation of robot design process	☐ Partially clear explanation of robot design process	☐ Clear explanation of robot design process	☐
☐ Minimal evidence that all team members were involved	☐ Partial evidence that all team members were involved	☐ Clear evidence that all team members were involved	☐

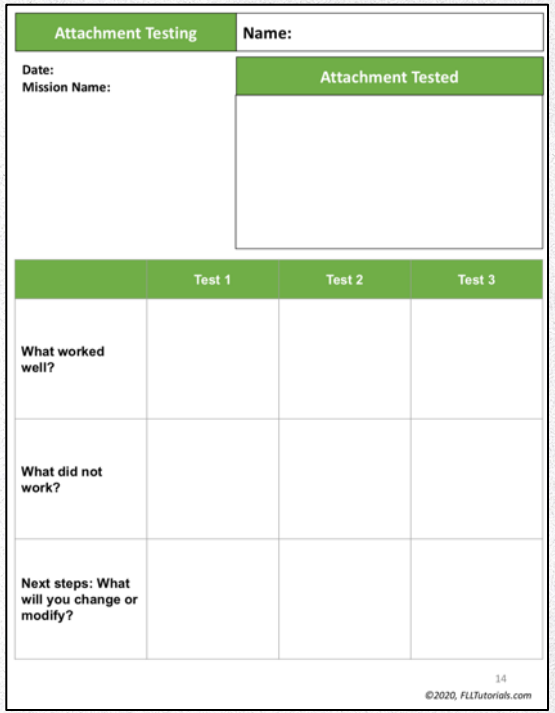
Focus on the Engineering Design Process

Step 1: Analyze the missions and develop a strategy
Step 2: Build and program a robot to meet that strategy
Step 3: Test the robot and make improvements as need
Step 4: Develop solutions to individual missions
Step 5: Test out code and robot
Step 6: Iterate as needed



Document Your Engineering Design Process

- How the team is following the engineering design process
- Document any changes made
- Document how much progress was made at every practice
- Document any new strategies
- Create goals for the next practice to plan what the team needs to work on next

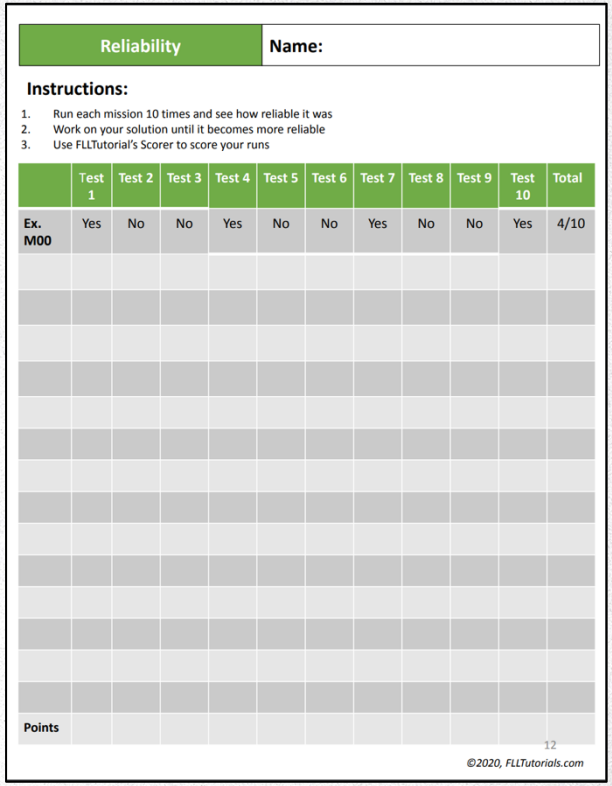


Attachment Testing	Name:		
Date: Mission Name:	Attachment Tested		
	Test 1	Test 2	Test 3
What worked well?			
What did not work?			
Next steps: What will you change or modify?			

14

Robot Testing is Very Important

- Test your runs 10 times to see if they work. If they do not, think about how to make them more reliable
- No two competition tables are alike
- Shift the mats, change tables, move the mission models slightly



Reliability	Name:

Instructions:

1. Run each mission 10 times and see how reliable it was
2. Work on your solution until it becomes more reliable
3. Use FLLTutorial's Scorer to score your runs

	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10	Total
Ex. M00	Yes	No	No	Yes	No	No	Yes	No	No	Yes	4/10
Points											

12

©2020, FLLTutorials.com

Judging

- Create a 5 min presentation
- Explain the engineering process and follow the rubric
- Point out the greatest strengths and innovations in both building and programming

BEGINNING 1	DEVELOPING 2	ACCOMPLISHED 3	EXCEEDS 4
			How has the team exceeded?
IDENTIFY – Team had a clearly defined mission strategy and explored building and coding skills they needed.			
☐ Unclear mission strategy	☐ Partially clear mission strategy	☐ Clear mission strategy	☐
☐ Limited evidence of building and coding skills in all team members	☐ Inconsistent evidence of building and coding skills in all team members	☐ Consistent evidence of building and coding skills in all team members	☐
DESIGN – Team produced innovative designs and a clear workplan, seeking guidance as needed.			
☐ Minimal evidence of an effective plan	☐ Partial evidence of an effective plan	☐ Clear evidence of an effective plan	☐
☐ Minimal explanation of robot and code's innovative features	☐ Partial explanation of robot and code's innovative features	☐ Clear explanation of robot and code's innovative features	☐
CREATE – Team developed an effective robot and code solution matching their mission strategy.			
☐ Limited explanation of their robot and its attachment and sensor functionality	☐ Simple explanation of their robot and its attachment and sensor functionality	☐ Detailed explanation of their robot and its attachment and sensor functionality	☐
☐ Unclear explanation of how code makes their robot act	☐ Partially clear explanation of how code makes their robot act	☐ Clear explanation of how code makes their robot act	☐
ITERATE – Team repeatedly tested their robot and code to identify areas for improve			
☐ Minimal evidence of testing their robot and code	☐ Partial evidence of testing their robot and code	☐ Clear robot	
☐ Minimal evidence their robot and code was improved	☐ Partial evidence their robot and code was improved	☐ Clear code	
COMMUNICATE – Team's explanation of the robot design process was effective a			
☐ Unclear explanation of robot design process	☐ Partially clear explanation of robot design process	☐ Clear desig	
☐ Minimal evidence that all team members were involved	☐ Partial evidence that all team members were involved	☐ Clear mem	

Innovation Project

Innovation Project is based on a yearly theme

2020-2021 RePlay Season - Help people get more active

2019-2020 City Shaper Season - Improve a building or space in your community

2018-2019 Into Orbit Season - Improve mental or physical health in space

2017-2018 Hydrodynamics Season -Improve the way people find, transport, use, or dispose of water.

Research Project Process/Engineering Design Process

- **Identify** a problem
- **Design** a solution
- **Create** a prototype
- **Share** with experts
- **Iterate** your design

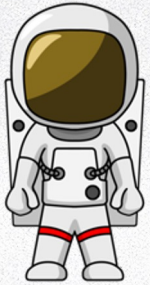
Innovation Project Rubric

- Project Rubric includes the engineering design process
- Provides team with the process of how they are going to be evaluated
- Teams are asked to create a drawing/prototype, share the solution with others, and iterate the design

BEGINNING 1	DEVELOPING 2	ACCOMPLISHED 3	EXCEEDS 4 *How has the team exceeded?*
IDENTIFY – Team had a clearly defined problem that was well researched.			
☐ Problem not clearly defined	☐ Partially clear definition of the problem	☐ Clear definition of the problem	☐
☐ Minimal research	☐ Partial research from more than one source	☐ Clear, detailed research from a variety of sources	☐
DESIGN – Team generated innovative ideas independently before selecting and planning which one to develop.			
☐ Minimal evidence of an inclusive selection process	☐ Partial evidence of an inclusive selection process	☐ Clear evidence of an inclusive selection process	☐
☐ Minimal evidence of an effective plan	☐ Partial evidence of an effective plan	☐ Clear evidence of an effective plan	☐
CREATE – Team developed an original idea or built on an existing one with a prototype model/drawing to represent their solution.			
☐ Minimal development of innovative solution	☐ Partial development of innovative solution	☐ Clear development of innovative solution	☐
☐ Unclear model/drawing of solution	☐ Simple model/drawing that helps to share the solution	☐ Detailed model/drawing that helps to share the solution	☐
ITERATE – Team shared their ideas, collected feedback, and included improvements in their solution.			
☐ Minimal sharing of their solution	☐ Shared their solution with user OR professional	☐ Shared their solution with user AND professional	☐
☐ Minimal evidence of improvements in their solution	☐ Partial evidence of improvements in their solution	☐ Clear evidence of improvements in their solution	☐
COMMUNICATE – Team shared a creative and effective presentation of their current solution and its impact on their users.			
☐ Presentation minimally engaging	☐ Presentation partially engaging	☐ Presentation engaging	☐
☐ Solution and its potential impact on others unclear	☐ Solution and its potential impact on others partially clear	☐ Solution and its potential impact on others clear	☐

Identify a Problem

- Teams research a topic according to the yearly theme
- Team members need to:
  - brainstorm ideas within the topic
  - conduct research
  - take notes when doing research
  - be sure everyone is participating
  - be aware of existing solutions
  - keep an open mind for ideas



<u>INTO ORBIT Sample:</u>
Identify a physical or social problem in space with long term space flight.

<u>Research Problem:</u>
Due to little to no gravity in space, body fluids rush toward the head and extremities causing many problems for astronauts.

Meet Experts

- Brainstorm what experts to contact
- Only choose experts who would benefit your team,
  - e.g. if you have an idea for an app, meet with a developer.
- Keep in mind that you can always meet with an expert virtually.
- Make sure that all team members can attend so that everyone can ask questions and learn as much as possible.
- Take notes to retain as much information as possible
- When meeting with an expert it is a good idea to take pictures to show the judges at your event

Go on Fieldtrips

- Great way to learn about problems
- E.g. the Tiger Techs visited New York City to learn about the city's urban planning.
  - Taking a field trip doesn’t have to be as big a going to New York City
  - Even a local park or city council
- Important to take notes so that you can reflect what you learned.
- Be sure to ask questions, take lots of pictures and observe as much as possible when taking field trips.

Field trip to US Airways to learn about engines

Design And Create A Solution

- Teams take research and apply it to a new innovative design
- Design should improve something or be brand new
- A good way to start is with multiple drawings to get the team's idea on paper
- Continue to meet with experts for feedback
- Prototypes are required this year for project
- For advanced teams, CAD could be an option for a prototype
- Documentation should be kept throughout the entire process for a journal

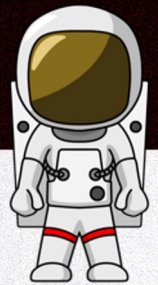
INTO ORBIT Sample Continued:

Design:
As a team, the Techs came up with many spacesuit designs based off of existing solutions.

For example, during a field trip we saw one existing solution at the Air and Space Museum in Washington, D.C.

Create a Solution:
Using information learned during the research phase, we designed a prototype. The name of our suit was Shape Shifter.

Iterate



- Teams test designs and then continually improve them
- Any feedback given by experts should be used to improve design
- Documentation is important during this step
  - Record results from testing
- Continue testing until team is satisfied with the results

INTO ORBIT Sample Continued:

Iteration Process:

The team sampled several materials for the layers of the space suit.

Fasteners such as buttons, zippers and velcro were tested to determine how strong they would be.

We reached out to a space suit design company to provide feedback for our suit.

Share With Experts

- Team's reach out to an individual, business, or an organization that would benefit from the solution and pitch idea to them
- Return to your original experts so that they can see the entire engineering design process
- Take feedback as a way to improve the design
- Sharing can be virtual or in person

INTO ORBIT Sample Continued:

Sharing with Experts:

The Techs shared their product with:

- a cardiologist
- professional athlete
- astronaut Mike Fincke
- biomedical engineer
- several experts at NASA

QUESTIONS?

This presentation and most of the team images are by Not the Droids You Are Looking For and Tiger Techs. Other images are obtained from FIRST LEGO League and FLLTutorials.com