Introduction to *FIRST* LEGO League Challenge

SUBMERGED℠

FIRST LEGO LEAGUE CHALLENGE

"I don't use kids to build robots. I use robots to build kids"

- Dean Kamen

FIRST DIVE
PRESENTED BY Qualcomm

SUBMERGED

INTO THE DEEP
PRESENTED BY RTX

REEFSCAPE
PRESENTED BY HAAS

Three *FIRST* Programs (K-12)

FIRST LEGO League: Discover, Explore, Challenge

FIRST Tech Challenge

FIRST Robotics Competition

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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 6, 2024: Challenge documents released

August-November 2024: Team meets weekly to solve the challenge

November-December 2024: Qualifiers

December 2024 -January 2025: State/Regional Championship

April 2025: World Championships

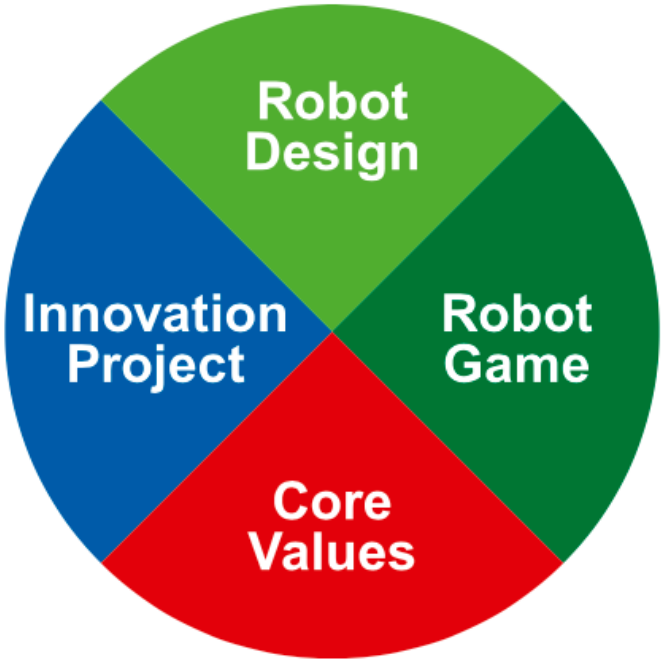
May 2025: Official Open Invitationals run by Program Development Partners

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.

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.

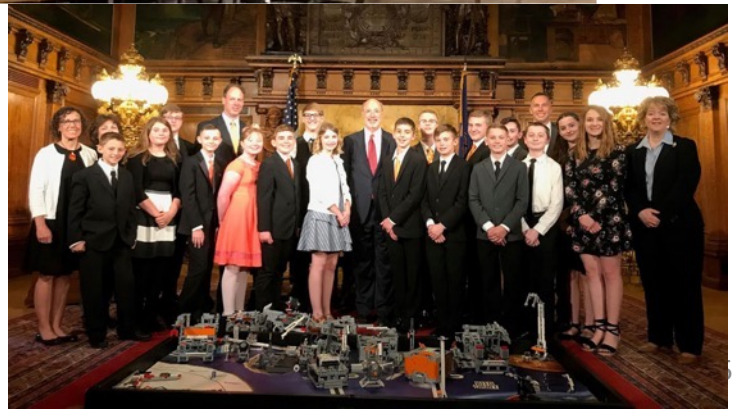
Learn to Communicate

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



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

Scoring Core Values

- There is no separate Core Values Rubric. Parts of the Innovation Project and Robot Design Rubric are used to evaluate Core Values.
- Gracious Professionalism is evaluated at the Robot Game Table.

Core Values Score is calculated by adding together five designated criteria from each judging rubric, for a total of ten rubric scores, plus three *Gracious Professionalism*® scores. *Gracious Professionalism* scores do not affect a team's Robot Game Score or rank.

Robot Game

Overview

- 4ft x 8ft table with a mat
- All mission models are LEGO-based
- LEGO MINDSTORMS or SPIKE Prime
- Yearly theme:
  - 2024 - SUBMERGED
  - 2023 - MASTERPIECE
  - 2022 - Super Powered
  - 2021 - Cargo Connect
  - 2020 - RePLAY

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

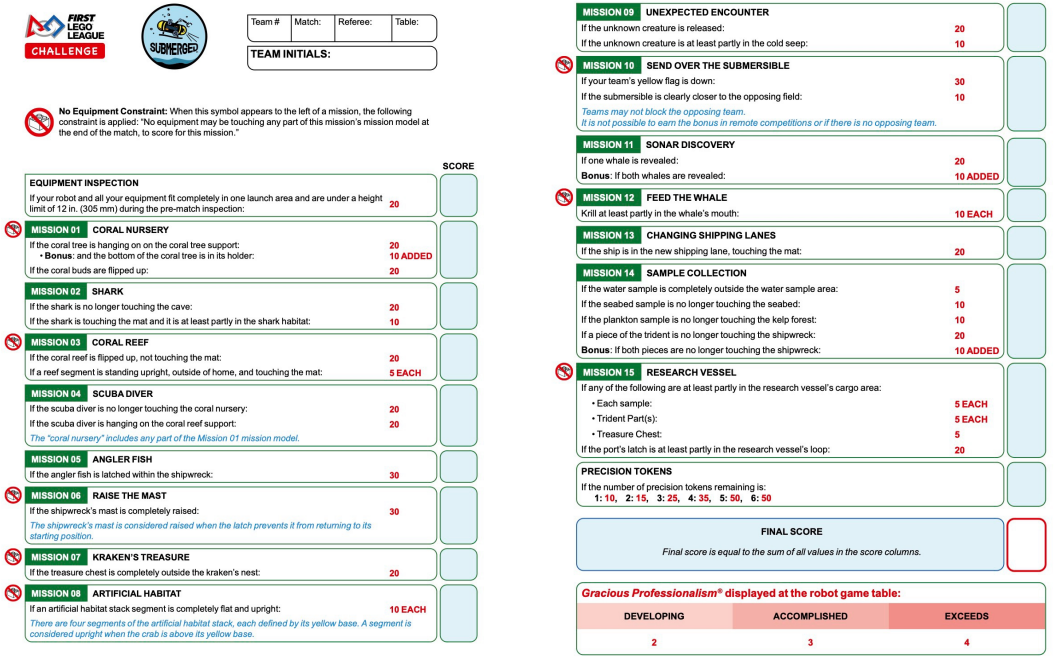
2024-25 Season: Ocean-based Theme

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 — SUBMERGED

Team #	Match:	Referee:	Table:

TEAM INITIALS:

No Equipment Constraint: When this symbol appears to the left of a mission, the following constraint is applied: "No equipment may be touching any part of this mission's mission model at the end of the match, to score for this mission."

		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 CORAL NURSERY** If the coral tree is hanging on on the coral tree support: 20 • **Bonus**: and the bottom of the coral tree is in its holder: 10 ADDED If the coral buds are flipped up: 20	
	MISSION 02 SHARK If the shark is no longer touching the cave: 20 If the shark is touching the mat and it is at least partly in the shark habitat: 10	
✓	**MISSION 03 CORAL REEF** If the coral reef is flipped up, not touching the mat: 20 If a reef segment is standing upright, outside of home, and touching the mat: 5 EACH	
	MISSION 04 SCUBA DIVER If the scuba diver is no longer touching the coral nursery: 20 If the scuba diver is hanging on the coral reef support: 20 *The "coral nursery" includes any part of the Mission 01 mission model.*	
	MISSION 05 ANGLER FISH If the angler fish is latched within the shipwreck: 30	
✓	**MISSION 06 RAISE THE MAST** If the shipwreck's mast is completely raised: 30 *The shipwreck's mast is considered raised when the latch prevents it from returning to its starting position.*	
✓	**MISSION 07 KRAKEN'S TREASURE** If the treasure chest is completely outside the kraken's nest: 20	
✓	**MISSION 08 ARTIFICIAL HABITAT** If an artificial habitat stack segment is completely flat and upright: 10 EACH *There are four segments of the artificial habitat stack, each defined by its yellow base. A segment is considered upright when the crab is above its yellow base.*	
	MISSION 09 UNEXPECTED ENCOUNTER If the unknown creature is released: 20 If the unknown creature is at least partly in the cold seep: 10	
✓	**MISSION 10 SEND OVER THE SUBMERSIBLE** If your team's yellow flag is down: 30 If the submersible is clearly closer to the opposing field: 10 *Teams may not block the opposing team.* *It is not possible to earn the bonus in remote competitions or if there is no opposing team.*	
	MISSION 11 SONAR DISCOVERY If one whale is revealed: 20 **Bonus**: If both whales are revealed: 10 ADDED	
✓	**MISSION 12 FEED THE WHALE** Krill at least partly in the whale's mouth: 10 EACH	
	MISSION 13 CHANGING SHIPPING LANES If the ship is in the new shipping lane, touching the mat: 20	
	MISSION 14 SAMPLE COLLECTION If the water sample is completely outside the water sample area: 5 If the seabed sample is no longer touching the seabed: 10 If the plankton sample is no longer touching the kelp forest: 10 If a piece of the trident is no longer touching the shipwreck: 20 **Bonus**: If both pieces are no longer touching the shipwreck: 10 ADDED	
✓	**MISSION 15 RESEARCH VESSEL** If any of the following are at least partly in the research vessel's cargo area: • Each sample: 5 EACH • Trident Part(s): 5 EACH • Treasure Chest: 5 If the port's latch is at least partly in the research vessel's loop: 20	
	PRECISION TOKENS If the number of precision tokens 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

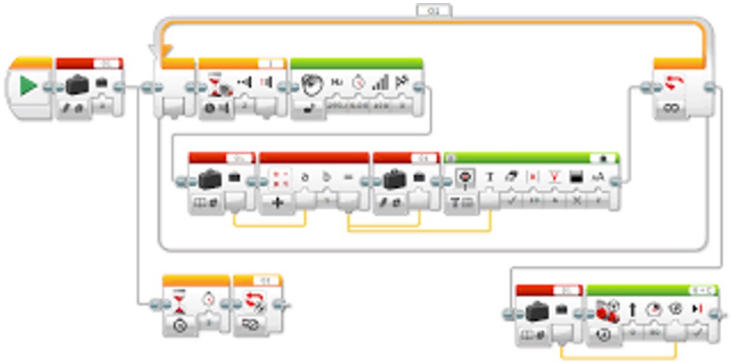
Robot Design

Types of Programming

EV3:

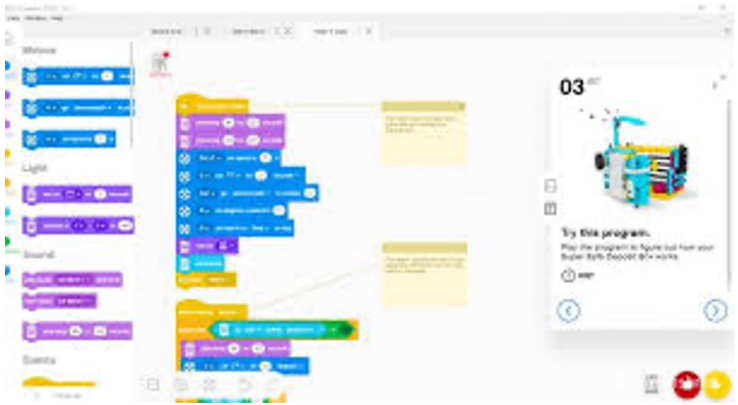
Block-based or Scratch-based

- Less condensed approach



SPIKE Prime:

- Scratch or Micro Python
- Linear approach



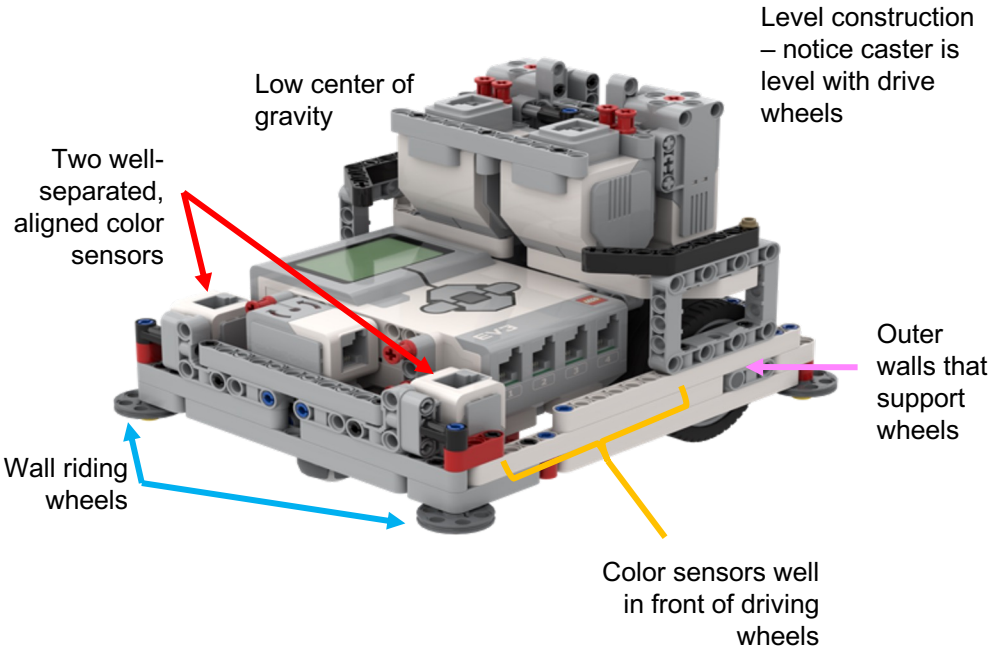
Programming Concepts to Learn Through *FIRST*

- 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

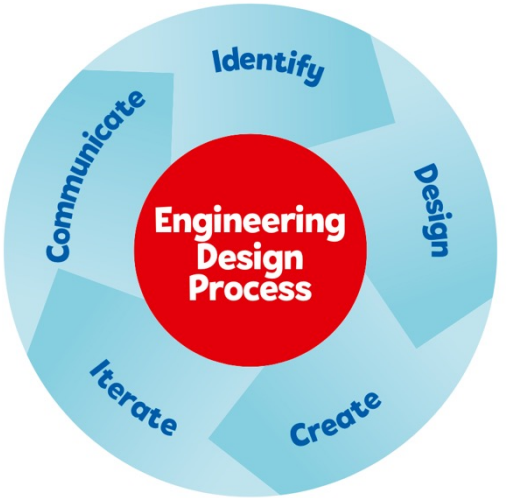
- How the team identifies what they need to do and how they do it
- Overall design of their robot
- What the team has created
- How the team tested their creations
- How well the team communicates how they've done in each of the other areas.
- Focus on all team members programming and building
- Team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

BEGINNING 1	DEVELOPING 2	ACCOMPLISHED 3	EXCEEDS 4 *How has the team exceeded?*
IDENTIFY – Team determined which missions to attempt, explored building and coding resources, and sought guidance as needed.			
☐ Minimal evidence of mission strategy	☐ Partial evidence of mission strategy	☐ Clear evidence of mission strategy	☐
⚙ Minimal use of building or coding resources	⚙ Some use of building or coding resources	⚙ Clear use of building or coding resources to support their mission strategy	⚙
DESIGN – Team members worked collaboratively on their designs and developed the building and coding skills needed.			
⚙ Minimal evidence that all team members contributed ideas	⚙ Partial evidence that all team members contributed ideas	⚙ Clear evidence that all team members contributed ideas	⚙
☐ Minimal evidence of building and coding skills in all team members	☐ Partial evidence of building and coding skills in all team members	☐ Clear evidence of building and coding skills in all team members	☐
CREATE – Team developed original designs or improved on existing ones according to their mission strategy.			
☐ Unclear explanation of attachments and their purpose	☐ Simple explanation of attachments and their purpose	☐ Clear explanation of innovative attachments and their purpose	☐
☐ Unclear explanation of code and/or sensor use	☐ Simple explanation of code and/or sensor use	☐ Clear explanation of innovative code and/or sensor use	☐
ITERATE – Team repeatedly tested their robot and code to identify areas for improvement and incorporated the findings into their solutions.			
☐ Minimal evidence of testing their robot and code	☐ Partial evidence of testing their robot and code	☐ Clear evidence of repeated testing of their robot and code	☐
⚙ Minimal evidence of improvements based on testing	⚙ Partial evidence of improvements based on testing	⚙ Clear evidence of improvements based on testing	⚙
COMMUNICATE – Team effectively explained what they learned from the robot design process and celebrated their progress.			
⚙ Unclear explanation of process and lessons learned	⚙ Simple explanation of process and lessons learned	⚙ Detailed explanation of process and lessons learned	⚙
⚙ Team shows minimal pride or enthusiasm for their work	⚙ Team shows partial pride or enthusiasm for their work	⚙ Team clearly shows pride or enthusiasm for their work	⚙

⚙ *Criteria on this page with this style of check box count dually toward Robot Design and Core Values awards rankings*

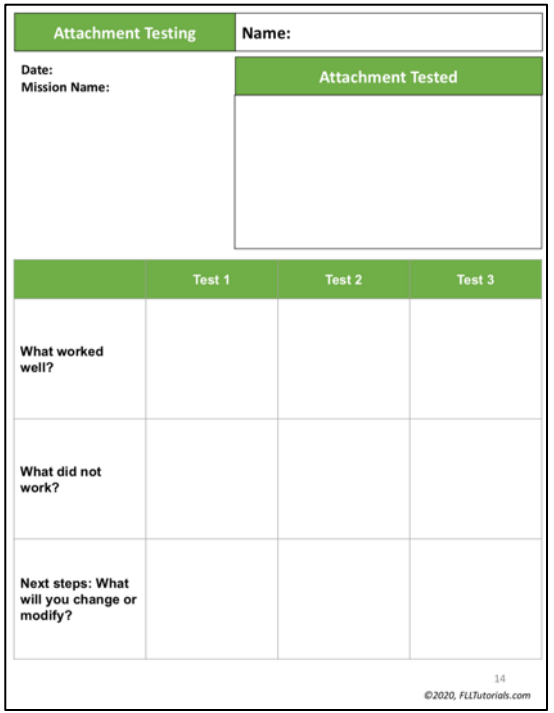
Focus on the Engineering Design Process

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?			

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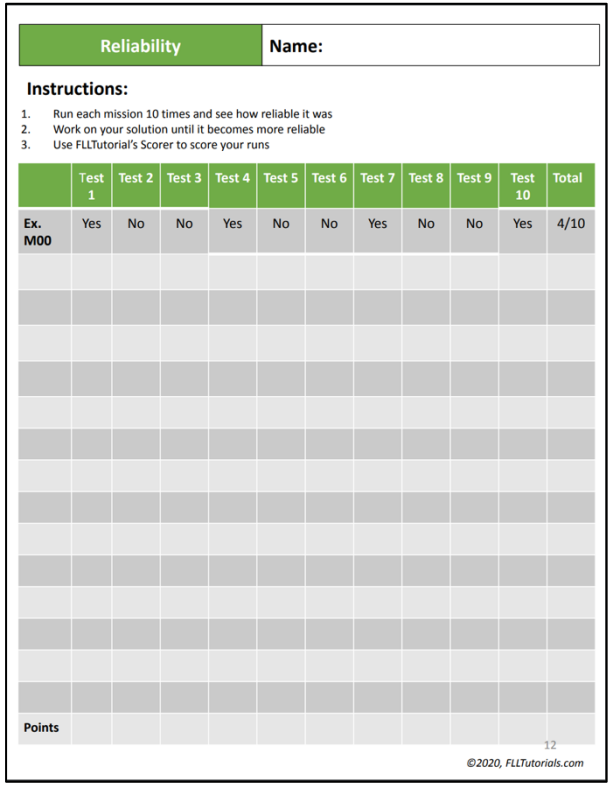
Robot Testing is Very Important

- 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

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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

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Innovation Project

Innovation Project is based on a yearly theme

2020-2021 RePlay Season - Help people get more active

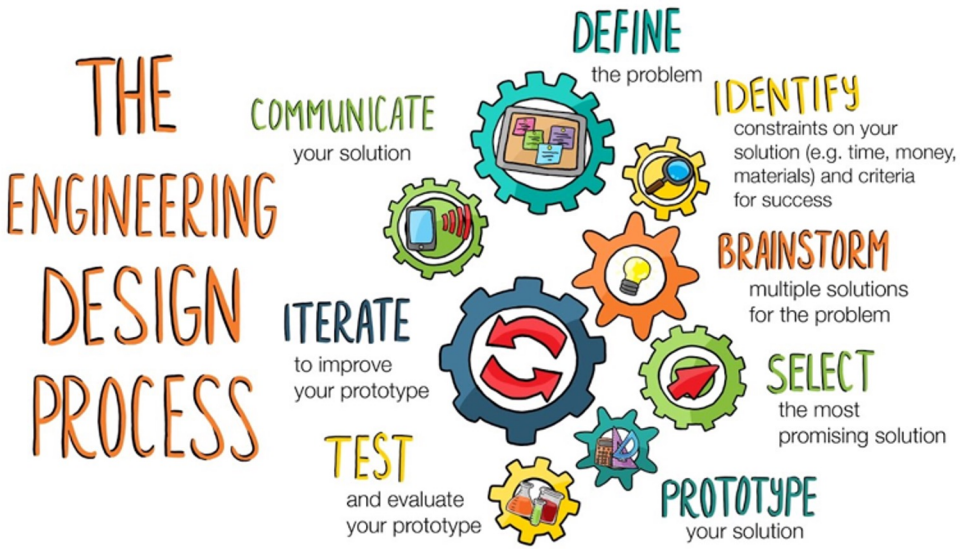
2019-2020 City Shaper Season - Improve a building or space in your community

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.			
☐ Unclear definition of the problem	☐ Partially clear definition of the problem	☐ Clear definition of the problem	☐
⚙ Minimal evidence of research	⚙ Partial evidence of research from one or more sources	⚙ Clear, detailed research from a variety of sources	⚙
DESIGN – Team worked together while creating a project plan and developing their ideas.			
☐ Minimal evidence of an effective project plan	☐ Partial evidence of an effective project plan	☐ Clear evidence of an effective project plan	☐
⚙ Minimal evidence that development process involved all team members	⚙ Partial evidence that development process involved all team members	⚙ Clear evidence that development process involved all team members	⚙
CREATE – Team developed an original idea or built on an existing one with a prototype model/drawing to represent their solution.			
⚙ Minimal explanation of innovation in solution	⚙ Simple explanation of innovation in solution	⚙ Detailed explanation of innovation in solution	⚙
☐ Unclear model/drawing that represents the solution	☐ Simple model/drawing that represents the solution	☐ Detailed model/drawing that represents the solution	☐
ITERATE – Team shared their ideas with others, collected feedback, and included improvements to their solution.			
☐ Minimal sharing of their solution with others	☐ Solution shared with at least one person/group	☐ Solution shared with multiple people/groups	☐
☐ Minimal evidence of improvements based on feedback	☐ Partial evidence of improvements based on feedback	☐ Clear evidence of improvements based on feedback	☐
COMMUNICATE – Team shared an effective presentation of their solution, its impact on others, and celebrated their team's progress.			
⚙ Unclear explanation of the solution and its potential impact on others	⚙ Partially clear explanation of solution and its potential impact on others	⚙ Clear explanation of solution and its potential impact on others	⚙
⚙ Presentation shows minimal pride or enthusiasm for their work	⚙ Presentation shows partial pride or enthusiasm for their work	⚙ Presentation clearly shows pride or enthusiasm for their work	⚙

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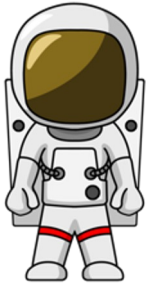
Identify a Problem

- 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.

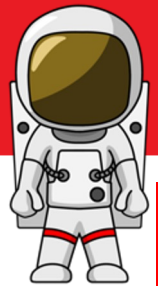
Meet Experts

- 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

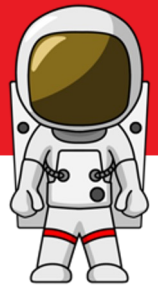
- Teams take research and apply it to a new innovative design
- Design should improve something or be brand new
- A good way to start is with multiple drawings to get the team's idea on paper
- Continue to meet with experts for feedback
- Prototypes are required this year for project
- For advanced teams,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

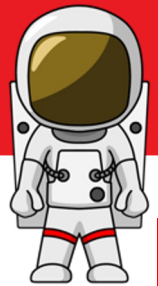
INTO ORBIT Sample Continued:

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