FIRST LEGO League Challenge Overview

Created by FRC 8027
(Not the Droids You are Looking For
and Tiger Techs alumni)

FIRST FORWARD PRESENTED BY Qualcomm

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

- Dean Kamen

Table of Contents

Three *FIRST* Programs (K-12)

FIRST LEGO League: Discover, Explore, Challenge

FIRST Tech Challenge

FIRST Robotics Competition

What is *FIRST* LEGO League Challenge?

FIRST LEGO League teams get to:

- Research real world problems
- Design, build, test and program robots using LEGO Robotics
- Apply real-world math and science concepts
- Learn critical thinking, team-building, and presentation skills
- Participate in tournaments and celebrations
- Understand and practice the *FIRST* Core Values

Team

- Children, ages 9 to 14, (grades 4-8) are eligible to participate in North America
- Elsewhere 9-16
- 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 17, 2021: Challenge documents released
August-November 2021: Team meets weekly to solve the challenge
November-December 2021: Qualifiers
December 2021 -January 2022: State/Regional Championship
April 2022: World Championships
May 2022: Open Invitationals

Team Costs

- Robot/Equipment - approx. $500.00 per robot (2 per team is useful)
  - SPIKE Prime, MINDSTORMS EV3, MINDSTORMS Robot Inventor
- Wooden Robotics Table - approx $100.00
- National Team Registration- $225
- LEGO Challenge Set - $75
- Local Tournament Registration - $75-$250 (more in some regions)
- Travel Expenses
- Shirts/Supplies

Three Parts of FIRST LEGO League Challenge

CORE VALUES

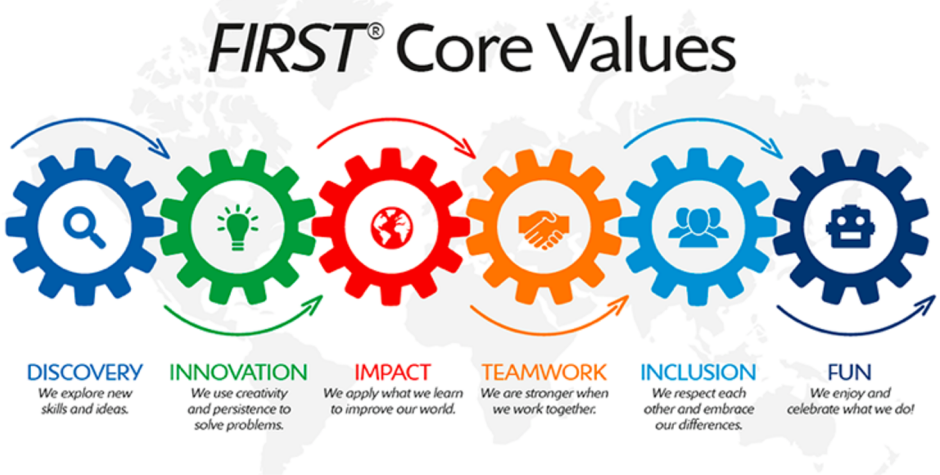
ROBOT GAME

PROJECT

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.

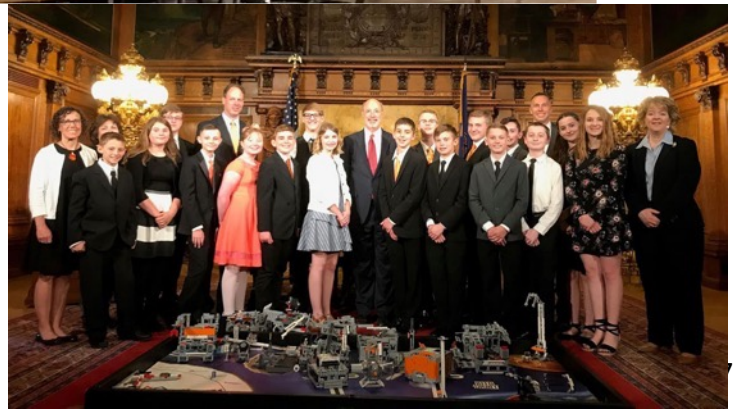
Learn to Communicate

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

Core Values, just like the other 2 aspects of FIRST has its own set of 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

Judging *may* include a Teamwork Activity (in some regions)

- This gives the judges a sense on how everyone works together and how a team can problem solve effectively in tough situations

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

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

CARGO CONNECT

FIRST LEGO LEAGUE CHALLENGE

Overview

- 4ft x 8ft table with a mat
- All mission models are LEGO-based
- LEGO MINDSTORMS or SPIKE Prime
- Yearly theme:
  - 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

CARGO CONNECT 2021 Season

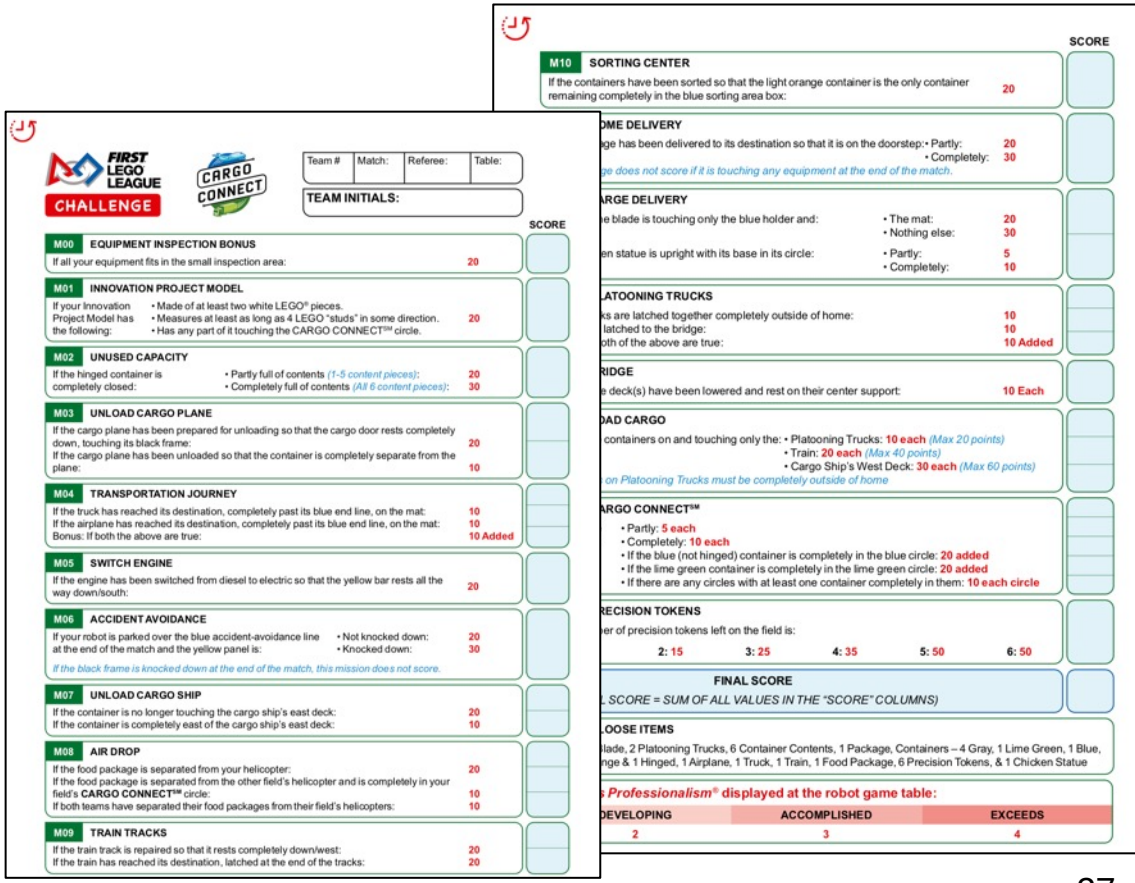
- The theme is based on cargo and transportation
- Lines are provided to allow the robot to line follow
- Missions are based on real-world scenarios such as moving a turbine blade, unloading/loading containers, etc.

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 — CARGO CONNECT

Team # | Match: | Referee: | Table:

TEAM INITIALS:

SCORE

M00 EQUIPMENT INSPECTION BONUS
If all your equipment fits in the small inspection area: 20

M01 INNOVATION PROJECT MODEL
If your Innovation Project Model has the following:
- Made of at least two white LEGO® pieces.
- Measures at least as long as 4 LEGO "studs" in some direction.
- Has any part of it touching the CARGO CONNECT™ circle.

20

M02 UNUSED CAPACITY
If the hinged container is completely closed:
- Partly full of contents *(1-5 content pieces)*: 20
- Completely full of contents *(All 6 content pieces)*: 30

M03 UNLOAD CARGO PLANE
If the cargo plane has been prepared for unloading so that the cargo door rests completely down, touching its black frame: 20
If the cargo plane has been unloaded so that the container is completely separate from the plane: 10

M04 TRANSPORTATION JOURNEY
If the truck has reached its destination, completely past its blue end line, on the mat: 10
If the airplane has reached its destination, completely past its blue end line, on the mat: 10
Bonus: If both the above are true: 10 Added

M05 SWITCH ENGINE
If the engine has been switched from diesel to electric so that the yellow bar rests all the way down/south: 20

M06 ACCIDENT AVOIDANCE
If your robot is parked over the blue accident-avoidance line at the end of the match and the yellow panel is:
- Not knocked down: 20
- Knocked down: 30

If the black frame is knocked down at the end of the match, this mission does not score.

M07 UNLOAD CARGO SHIP
If the container is no longer touching the cargo ship's east deck: 20
If the container is completely east of the cargo ship's east deck: 10

M08 AIR DROP
If the food package is separated from your helicopter: 20
If the food package is separated from the other field's helicopter and is completely in your field's CARGO CONNECT™ circle: 10
If both teams have separated their food packages from their field's helicopters: 10

M09 TRAIN TRACKS
If the train track is repaired so that it rests completely down/west: 20
If the train has reached its destination, latched at the end of the tracks: 20

SCORE

M10 SORTING CENTER
If the containers have been sorted so that the light orange container is the only container remaining completely in the blue sorting area box: 20

…OME DELIVERY
…ge has been delivered to its destination so that it is on the doorstep:
- Partly: 20
- Completely: 30

…ge does not score if it is touching any equipment at the end of the match.

…RGE DELIVERY
…e blade is touching only the blue holder and:
- The mat: 20
- Nothing else: 30

…en statue is upright with its base in its circle:
- Partly: 5
- Completely: 10

…LATOONING TRUCKS
…ks are latched together completely outside of home: 10
…latched to the bridge: 10
…oth of the above are true: 10 Added

…RIDGE
…e deck(s) have been lowered and rest on their center support: 10 Each

…OAD CARGO
…containers on and touching only the:
- Platooning Trucks: 10 each *(Max 20 points)*
- Train: 20 each *(Max 40 points)*
- Cargo Ship's West Deck: 30 each *(Max 60 points)*

…on Platooning Trucks must be completely outside of home

…ARGO CONNECT™
- Partly: 5 each
- Completely: 10 each
- If the blue (not hinged) container is completely in the blue circle: 20 added
- If the lime green container is completely in the lime green circle: 20 added
- If there are any circles with at least one container completely in them: 10 each circle

…RECISION TOKENS
…er of precision tokens left on the field is:
2: 15 | 3: 25 | 4: 35 | 5: 50 | 6: 50

FINAL SCORE
…L SCORE = SUM OF ALL VALUES IN THE "SCORE" COLUMNS)

…LOOSE ITEMS
…lade, 2 Platooning Trucks, 6 Container Contents, 1 Package, Containers – 4 Gray, 1 Lime Green, 1 Blue, …nge & 1 Hinged, 1 Airplane, 1 Truck, 1 Train, 1 Food Package, 6 Precision Tokens, & 1 Chicken Statue

…Professionalism® displayed at the robot game table:

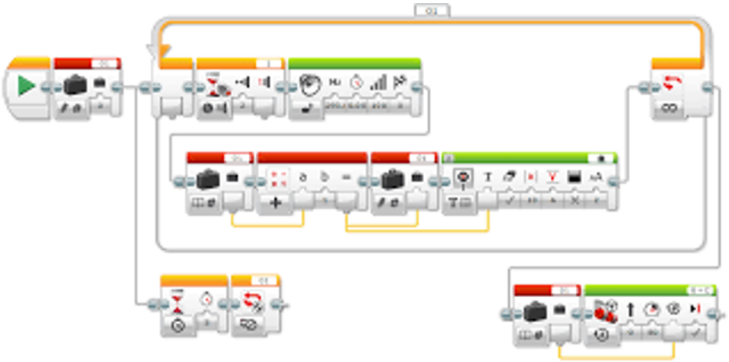
…DEVELOPING	ACCOMPLISHED	EXCEEDS
2	3	4

Types of Programming

EV3:

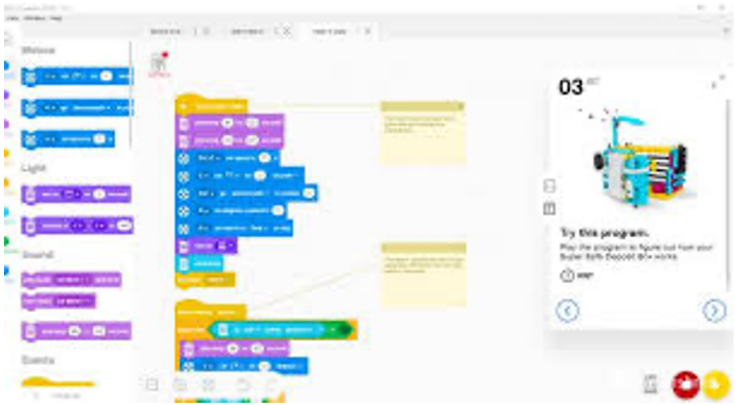
Block-based or Scratch-based

- Less condensed approach



SPIKE Prime:

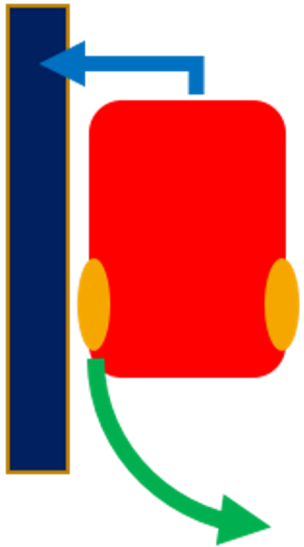
- Scratch or Micro Python
- Linear approach



Programming Concepts to Learn Through FIRST

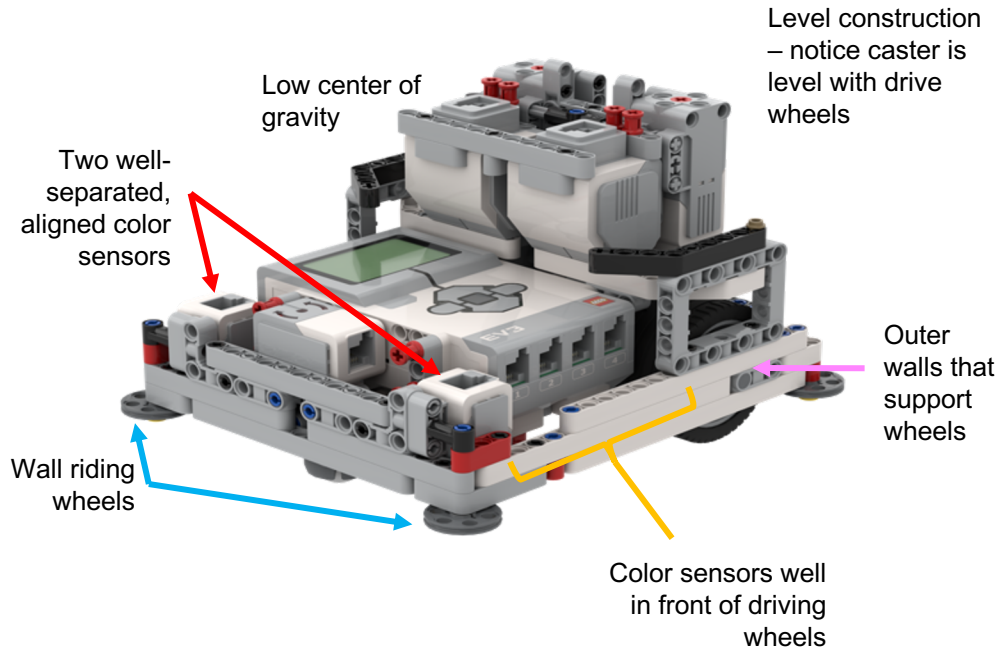
- Basic skills
  - Basic sensor usage, loops, switches, basic line following
- Intermediate skills
  - Custom MyBlocks, decision/logic blocks
- Advanced skills
  - Proportional control, PID line follower, gyro sensor usage, menu system

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

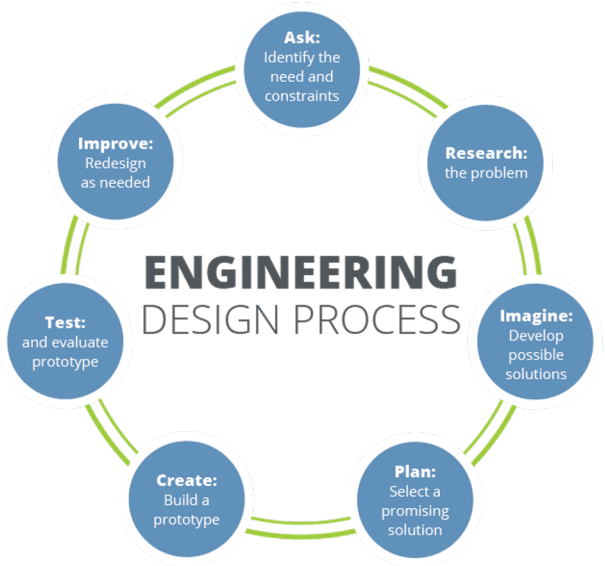
Step 2: Build and program a robot to meet that strategy

Step 3: Test the robot and make improvements as needed

Step 4: Develop solutions to individual missions

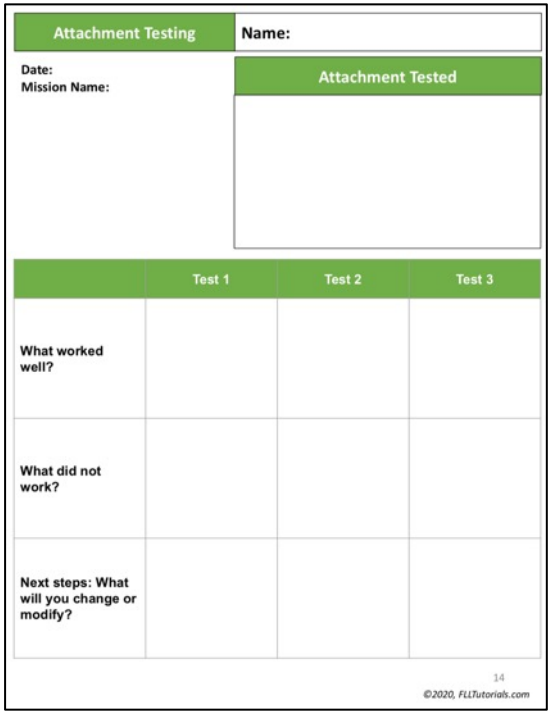
Step 5: Test out code and robot

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



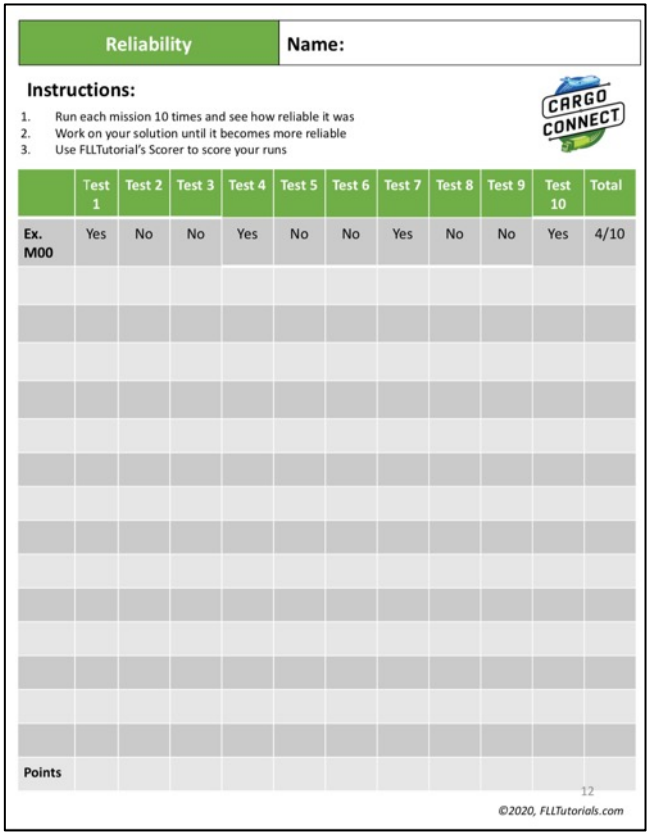
Attachment Testing	Name:
Date: Mission Name:	Attachment Tested

	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

Judging

- Create a presentation that showcases the work of the team (usually 4-5 mins)
- Explain the engineering process.
- Point out the greatest strengths and innovations in both building and programming

PROJECT

Innovation Project is based on a yearly theme

2020-2021 RePlay Season - Help people get more active

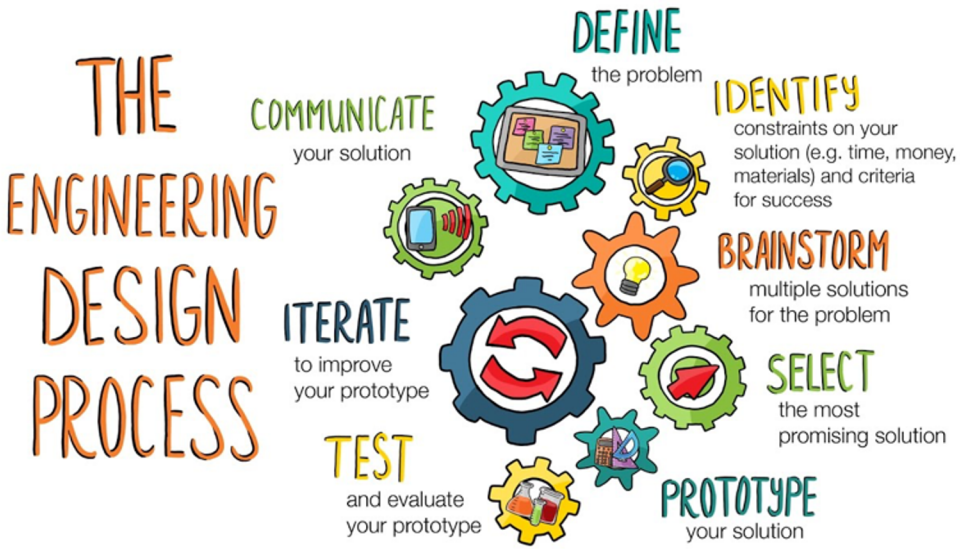
2019-2020 City Shaper Season - Improve a building or space in your community

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



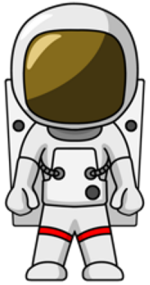
Innovation Project Rubric

- 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

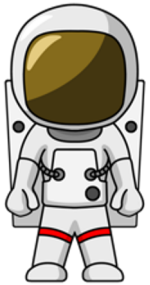
Go on Fieldtrips

- 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



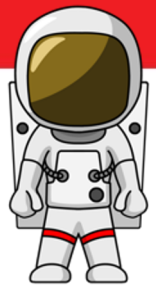
<u>INTO ORBIT Sample Continued:</u>

<u>Design:</u>
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.

<u>Create a Solution:</u>
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:

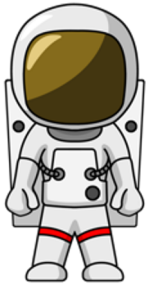
Iteration Process:

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

CARGO CONNECT

FIRST LEGO LEAGUE CHALLENGE

What is Global Innovation Award?

- Started in 2011
- Showcases teams' innovative projects
- GIA requires teams to go more in depth with their project than before
- Many GIA teams get patents, meet leaders, etc.
- There is no additional cost to participate in GIA other than travel costs if you make top 20

How do you qualify for it?

- Most regions nominate the top-ranked Innovative Solution team(s) from their Championship.
- Some have a separate judging process
- Nominated teams submit an application to qualify for the top 20
- Application has many essay questions about the project and solution
- The top 20 submit an Engineering Change document before they attend the final event if they have made any changes since submission

What happens when you make Top 20?

- 20 teams semi-finalist compete at the annual event
- Prior to the event, teams create pitches
- At the event, teams present their idea to a panel of judges
- $20,000 to help further develop product
- Teams interact with each other
- Teams meet experts in field
- Learn about patents and innovation

GIA has a seperate rubric

- Different from normal project rubric
- Rubric will help team think more in depth than before
- Teams who base strategy around rubric will excel

Global Innovation Award Rubric

Team:

Submission Name:

For each criterion, select the box that best describes the team's accomplishments.

Beginning	Developing	Accomplished	Exemplary
Problem Identification	**Clear definition of the problem being studied**		
unclear; few details	partially clear; details missing	mostly clear; detailed	clear; very detailed
Innovation	**Degree to which the team's solution makes life better by improving existing options, developing a new application of existing ideas, or solving the problem in a completely new way**		
existing solution/application	solution/application contains some original element(s); potential added value	original solution/application; potential added value	original solution/application; demonstrated added value
Solution Development	**Use of a systematic process to develop the solution, where alternative solutions are considered and narrowed, the chosen solution is evaluated and improved, feasibility of process solutions assessed**		
process AND explanation need improvement	process OR explanation need improvement	systematic and well-explained, including evaluation or verification	process uses evaluation or verification across multiple steps
Implementation	**Consideration of factors for implementation (such as cost, ease of manufacturing, etc.)**		
minimal factors considered; idea not feasible	some factors considered; idea may be feasible	factors well considered; some question about proposed solution	factors well considered and feasibility confirmed by professionals in the field

Motivation to Implement (check if demonstrated)	**Team demonstrates motivation to implement (clear idea of a next step(s) to make a reality; OR consultation with a professional for advice beyond production, such as business, marketing, design, etc.; OR demonstrates strong desire to see the end-user's problem improve with this solution)**
☐	

Comments:

Please provide 1-2 comments about this team's submission. Please write one comment describing something you liked about this idea and one thing you think the team can improve. Comments will be provided to the teams, so please make them positive and constructive.

Why is GIA important?

- The GIA leaves a huge impact on teams
- Friendships are made over the few days
- Teams will meet experts and inspirational people
- Many teams will further develop their product and get patents
- These experiences will prepare teams for future FIRST programs

2010 Body Forward

- BOB-1 Hand Device by The Flying Monkeys of Ames, Iowa
- Low-cost prosthetic device
- Represented FIRST at the White House Science Fair
- June 16, 2015: U.S. Patent No. 8,840,157

2016 Animal Allies

- The H20 Post by The Hydrators of Oakville, Ontario, Canada
- The H20 Post (Horses Hydrating Outside) monitors the amount of water horses drink.

2020 City Shaper

- E-Wall by Aldeatron Robotix of the Canary Islands, Spain
- Low cost, lightweight, eco-friendly building block made from recycled cardboard and Fountain grass.

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.