ANIMAL ALLIES

2016/2017

Challenge Guide

FIRST LEGO LEAGUE

LEGO education

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New to *FIRST*® LEGO® League? This Challenge Guide provides season-specific resources to help you work with your team on this year's Challenge. For a complete step-by-step guide to the season and a helpful selection of strategy worksheets, check out the *FIRST* Steps modules: http://www.firstlegoleague.org/first-steps

Glossary

allies	People, countries, or other groups that have joined together for a special purpose.
animal	In the ANIMAL ALLIES^{SM} Challenge, an animal is any member of the scientific animal kingdom (besides humans) that is currently alive today.
animal kingdom	Scientists divide all living things into groups called "kingdoms." These kingdoms help us understand the variety of life found on Earth. The Animal Kingdom is the group that includes most of the living things we see: mammals, reptiles, birds, insects, and many more.
bioload	The number and type of animals an aquarium tank can hold.
biomimicry	Applying lessons from animals and plants to the invention of healthier, more sustainable technologies for people.
conservation	The care and protection of animals and/or natural resources such as forests and water.
ecosystem	The physical habitat and all of the animals and plants that live there.
enrichment	Activities and challenges added to an animal's routine to make their lives better through physical or mental exercise. Finding proper enrichment for each species can be a great challenge.
feces	Poop from an animal. Also known as manure, scat, waste, droppings, guano, or dung (depending on the animal).
habitat	The place where an animal or plant lives. An animal's "natural habitat" is where this animal would normally live without human intervention.
livestock	Animals kept and raised on a farm to benefit people. Some examples may include cows, horses, pigs, and sheep.
manure	Feces from a large livestock animal like a cow or horse.
plasticity	How adaptable an animal is to changes in its environment or its ability to move between environments.
prosthesis	A device designed to replace a missing body part or to make a part of the body work better.
taxonomy	Sorting or classification of living things into groups that have specific traits in common.

The Core Values

The Core Values are the heart of *FIRST*® LEGO® League. By embracing the Core Values, participants learn that friendly competition and mutual gain are not separate goals, and that helping one another is the foundation of teamwork. Review the Core Values with your team and discuss them whenever they are needed.

- We are a team.
- We do the work to find solutions with guidance from our coaches and mentors.
- We know our coaches and mentors don't have all the answers; we learn together.
- We honor the spirit of friendly competition.
- What we discover is more important than what we win.
- We share our experiences with others.
- We display Gracious Professionalism® and Coopertition® in everything we do.
- We have FUN!

The Core Values Poster

The Core Values poster is designed to help the Core Values Judges at your tournament learn more about your team and its unique story.

> Some regions require all teams to prepare a Core Values poster, while others do not. Either way, the poster is a great tool to help your team think about how they implement the Core Values in team meetings and elsewhere. Check with your tournament organizer to see if your team is expected to bring a Core Values poster into the Core Values judging session.

Follow these steps with your team to create a Core Values poster:

1. Discuss ways your team used the Core Values this season – both in team meetings and in other parts of life. Make a list of examples.

2. Ask your team to select examples that highlight the specific Core Values areas below. These are typically the most challenging categories for Judges to explore during judging sessions. The poster can help your team present their successes in an organized format.
   a. **Discovery**: Provide examples from the season about things your team discovered that were not focused on gaining an advantage in the competition or winning an award. Tell the Judges how the team balanced all three parts of *FIRST*® LEGO® League (Core Values, Project and Robot Game), especially if they were really excited about one part.
   b. **Integration**: Provide examples of how your team applied the Core Values and other things you learned through *FIRST* LEGO League to situations outside of team activities. Let the Judges know how team members integrated new ideas, skills and abilities into their everyday life.
   c. **Inclusion**: Describe how your team listened to and considered ideas from everyone and made each team member feel like a valued part of the team. Share with the Judges how they accomplished more by working together than any team member could have done alone.

d. **Coopertition**: Describe how your team honors the spirit of friendly competition. Include information about how your team provided assistance to and/or received assistance from other teams. Share with the Judges how your team members help each other, and help other teams to prepare for a potentially stressful competition experience.

e. **Other**: Use the middle of the poster to highlight anything else your team would like to share with the Judges about the remaining Core Values criteria. Maybe consider sharing examples of Team Spirit, Respect, or Teamwork.

3. Have your team create their Core Values poster using the format below. The overall size of the poster should be no more than the measurements shown, and it may be smaller, especially if required for travel needs. The poster may be rolled or assembled on site.


WANT TO LEARN MORE? VISIT http://firstlegoleague.org/challenge#animal-allies
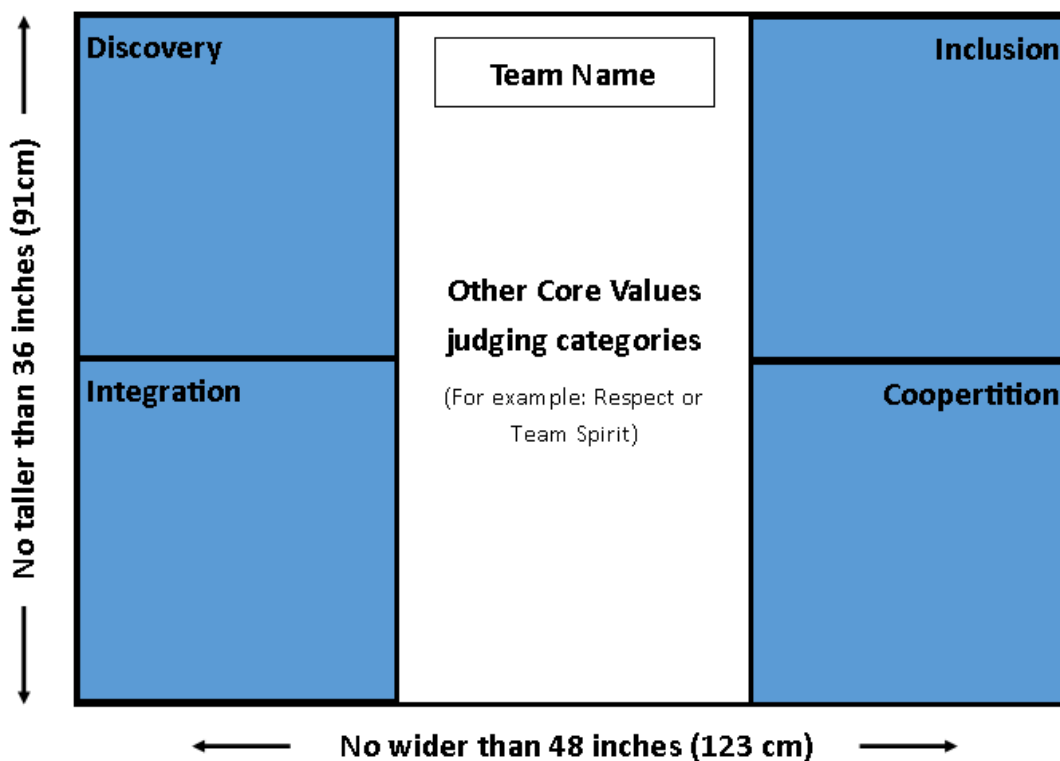
- Find the Core Values listed in the Challenge.
- Learn about what to expect from Core Values Judging and read tips from experienced Coaches in the Coaches' Handbook: **http://firstinspires.org/resource-library/fll/coaches-handbook**.
- Your team will be assessed in the judging room using a standard rubric. Review the Core Values judging information and rubric.

If you are completely new, check out the *FIRST* LEGO League Resource Library for videos, tips, and additional helpful rookie links: **http://firstinspires.org/resource-library**.
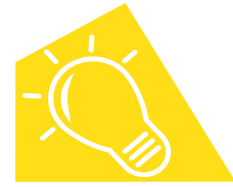
The Project

The Project Process

THINK ABOUT IT

When you meet an animal at the zoo, on a farm, or in your home, have you ever thought about whether that interaction helps you, the animal, or both? Share these situations with your team. Who is helping or being helped in each one?

Rosa lives on a farm in Syddanmark, Denmark. Rosa leads a pretty good life, for a cow. She eats grass, takes a nap, and – when she feels it's time – she visits the robotic milking machine. The machine uses lasers to find Rosa's udders, clean them, and then pump the milk. Rosa munches on special grain while the machine works. When it's done, Rosa feels better and leaves the milking machine to find some more tasty grass.

Randy loves to hike in the mountains of New Hampshire, USA. However, Randy lost his sight many years ago, so hiking mountains might be difficult and dangerous. Luckily, Randy has a friend who also likes to hike: Autumn. As a trained guide dog, Autumn knows how to identify obstacles that might harm Randy or her. Even through the winter, Autumn helps Randy find a safe path over snow-covered tree roots and boulders.

Elena carefully threads fruit onto a wire at the Omaha Zoo & Aquarium in Nebraska, USA. In the wild, fruit bats would generally eat fruit hanging from trees. Since fruit doesn't grow on the imitation trees in the jungle exhibit, Elena must think of creative ways to feed the bats. Instead of placing all of the fruit in a big pile, Elena hangs fruit from hooks or hides it somewhere unexpected in the exhibit. This way, breakfast is also an enrichment activity for the bats.

In the past, lions often attacked the livestock in Richard's village in Kenya. Residents hunted the lions to protect their homes and farms. After trying a few ideas, Richard discovered that moving lights could scare the lions away without harming them. He invented a system of flickering lights and installed them around the village. The lights kept the lions away from the livestock, so the people had no reason to hunt the lions.

For ANNIMAL ALLIES^{SM}, think of people and animals as allies in the quest to make life better for everyone. Sometimes people help animals and sometimes animals help people. Your team's Project mission this season is to make our interactions with animals better – hopefully better for all of us.

IDENTIFY A PROBLEM

Ask your team to think about all the different ways that people interact with animals. Sometimes people purposely seek out animals (like Autumn helping Randy hike the mountain) and sometimes it happens by accident (like the lions attacking Richard's livestock). Have your team pick a situation in which people and animals interact, then identify a specific problem they want to solve.

Not sure where to start?

Try this process to help your team choose and explore an animal problem:

As a Team – Choose an animal. It might be an animal that lives in your home or neighborhood. It might be an animal that you have seen at a zoo, aquarium, or farm. It might be an animal that lives in the forest, ocean, desert or another habitat.

Learn about the ways people interact with this type of animal. (People must interact with this animal in some way to be valid for ANIMAL ALLIES^{SM}.) Ask questions like:

- When people interact with your animal, is it on purpose or by accident?
- Does the interaction help or hurt people, the animal, or both?
- What type of professionals work with or study your animal?
- Do you notice any ways that the interaction could be better – more productive, healthier, or happier for either the person or the animal? Look for these problems as you research.

This might be a great time for the team to interview a professional. The professional could be someone who works directly with animals or researches animal problems for his or her job. Can a professional help your team learn about animal health, safety, enrichment, or living environments?

As a Team – Identify a specific problem with the way people interact with your animal. You might select a problem in one of these areas (or add your own):

- Animals accidentally harmed by an activity that helps people
- Recreating a natural living environment inside human-made buildings
- Feeding
- Finding the right enrichment activities for a specific animal
- Healing injured or sick animals
- Managing feces
- Natural animal instincts accidentally harming people
- Conserving endangered species
- Transportation

> In the ANIMAL ALLIES^{SM} Challenge, an *animal* is any member of the scientific animal kingdom (besides humans) that is currently alive today.

After your team selects a problem, the next step is to find out about the current solutions. Encourage them to research their problem using resources like:

- News articles
- Documentaries or movies
- Interviews with professionals working in the field
- Ask your local librarian
- Books
- Online videos
- Websites

Field trips are a great way to learn about a new topic. Consider requesting a tour or interview from a local business, educational institution, or other animal-related site. However, some locations may have rules restricting visitors, or they may not have someone available to give an interview. If they say "no," ask about virtual tours online or other institutions you could contact.

After your team selects a problem, find out about the current solutions. Why does this problem still exist? Why aren't the current solutions good enough? What could be improved?

As a Team – Decide when you feel that you know your team's animal and problem pretty well. Then, move on to the "Design an Innovative Solution" section.

DESIGN A SOLUTION

Next, your team will design a solution to the problem. Any solution is a good start. The ultimate goal is to design an **innovative** solution that adds value to society by improving something that already exists, using something that exists in a new way, or inventing something totally new.

As a Team – Think about:

- What could be done better? What could be done in a new way?
- Could your solution make people and animals more productive, healthier, or happier?
- How can you reimagine the way we work with or study animals?
- Could you use an adaptation from an existing animal (biomimicry) to help solve the problem you identified?

Ask your team to think of your problem like a puzzle. Brainstorm! Then turn the problem upside down and think about it in a completely different way. Imagine! Get silly! Even a "silly idea" might inspire the perfect solution. Encourage team members to try one idea (or more), but be prepared that the first idea may need some improvements.

Make sure your team thinks about how they could make their solution a reality. Try asking them questions like:

A great solution might be a device or technology, but maybe not. Look for the solution that the team thinks will solve the problem best. Team members should be prepared to tell the judges what makes their idea better than the existing solutions.

- Why would your solution succeed when others have failed?
- What information would you need to estimate the cost?
- Do you need any special technology to make your solution?
- Who would be able to use it?

Remember, your team's solution does not need to be completely new. Inventors often improve an idea that already exists or use something that exists in a new way.

SHARE WITH OTHERS

Once the team has designed a solution, the next step is to share it!

As a Team – Think about who your solution might help. How can you let them know that you have solved their problem?

- Can you present your research and solution to people who own, sell, or care for animals?
- Can you share with a professional or someone who helped you learn about your problem?
- Can you think of any other groups of people who might be interested in your idea?

It might be helpful for your team to share with someone who could provide real-world feedback about the solution. Getting input and improving are part of the design process for any engineer. It is OK to revise an idea if the team receives some helpful feedback.

When your team plans their presentation, encourage them to use the talents of team members. Teams often explore creative presentation styles, but it is also important to keep the focus on your team's problem and solution. Sharing can be simple or elaborate, serious or designed to make people laugh while they learn.

No matter what presentation style your team chooses, remember to keep the process fun!

The Project Presentation

Any inventor must present their idea to people who can help them make it a reality, such as engineers, investors, or manufacturers. Like adult inventors, the Project presentation is your team's chance to share their great Project work with the Judges.

All regions require teams to prepare a Project presentation. As long as your team covers the basic Project information, they may choose any presentation style they like. Check with your tournament organizer to see if there are any size or noise restrictions in the judging rooms.

Your team's presentation may include posters, slideshows, models, multimedia clips, props, costumes, and more. Creativity in the presentation is rewarded, but covering all of the essential information is even more important.

Teams will only be eligible for Project awards if they:
- Identify a **problem** that meets this year's criteria.
- Explain their **innovative solution**.
- Describe how they **shared with others** prior to the tournament.

Presentation requirements:
- All teams must present **live.** The team may use media equipment (if available) only to enhance the live presentation.
- **Include all team members.** Each team member must participate in the Project judging session.
- Set up and complete the presentation in **five minutes or less** with no adult help.

The teams who excel at tournaments also use the Project presentation to tell the Judges about their sources of information, problem analysis, review of existing solutions, elements that make their idea innovative, and any plans or analysis related to implementation.

Project Resources

VIDEO

Guide dog training – Find out what it means to train and work with a guide dog.
http://www.wmur.com/new-hampshire-chronicle/thursday-february-12th-guide-dog-training/31315342

Making peace with lions - Richard Tuere describes his invention to help people and lions live more peacefully together in Kenya.
http://www.ted.com/talks/richard_turere_a_peace_treaty_with_the_lions

WEBSITES AND ARTICLES

Animal Kingdom – See what scientists include in the animal kingdom and find links to more information about specific categories of animals.
http://www.kidport.com/reflib/science/animals/Animals.htm

 Animal swap – Have you ever thought about what a puffin costs? Find out why many zoos and aquariums trade animals rather than buying them.
http://n.pr/1pSVVa0

Biomimicry – What is biomimicry and how can it help you solve problems?
http://www.asknature.org

Crittercam – Learn about how National Geographic's Crittercam makes studying animals both more productive and less disruptive for the animals.
http://animals.nationalgeographic.com/animals/crittercam/

Delving into Dung – You can learn a lot about animals by studying their poop.
https://student.societyforscience.org/article/cool-jobs-delving-dung

Earth Rangers – The Earth Rangers blog posts articles about interesting animals and the problems they face. http://www.earthrangers.com/wildwire

Go local – Zoos, aquariums, and animal sanctuaries often provide great resources and programs to learn about animals. Use a search engine to find these animal resources in your area or around the world.

Meet a zoo animal – The Association of Zoos and Aquariums would like to show you how zoos and aquariums work with all sorts of animals.
http://azaanimals.org

BOOKS

Scientists in the Field
This series from the publisher Houghton Mifflin contains many books about scientists and other professionals who work with animals. Some examples include:
The Frog Scientist (2011)
The Hive Detectives (2010)
The Octopus Scientists (2015)
Swimming with Hammerhead Sharks (2011)
Wild Horse Scientists (2012)

Wild Animal Neighbors: Sharing Our Urban World
Learn about the conflicts between seven different animals and the people they encounter in cities around the world.
By Ann Downer, Twenty-First Century Books (2014)

Working Like a Dog: The Story of Working dogs through history
Provides many examples of the ways that humans have interacted with dogs throughout history.
By Gena K. Gorrell, Tundra Books (2003)

Ask a Professional

Talking with professionals (people who work in the field of this year's Challenge theme) is a great way for your team to:

- Learn more about this season's theme.
- Find ideas for your ANIMAL ALLIES[SM] problem.
- Discover resources that might help with your research.
- Get feedback on your innovative solution.

EXAMPLES OF PROFESSIONALS

Consider contacting people who work in the following professions. See if your team can brainstorm any other jobs to add to the list. Many company, professional association, government, and university websites include contact information for professionals.

Job	What they do	Where they may work
animal curator	Manages a collection of animals. May involve planning for animal care, display, enrichment, and acquiring or trading.	Aquariums, zoos, animal refuges
aquarist	Cares for aquatic (water) animals through feeding, training, and generally caring for their wellbeing.	Aquariums, marine research labs, government natural resources departments, theme parks, pet stores
farm manager	Runs a farm that produces crops, livestock, or dairy products.	Farms, universities
game warden	Enforces laws related to fishing, hunting, and owning of wild animals.	Local or national government agencies
herder	Cares for livestock in places where these animals wander through pasture lands.	Farms, ranches, traditional communities, wilderness areas
nutritionist	Uses knowledge about food science to suggest diet options and adjustments for animals.	Zoos, aquariums, pet food companies
rancher	Owns or works on a ranch where livestock are raised.	Ranches
trainer	Trains animals for obedience, performance, riding, or assisting people.	Obedience schools, stables, theme parks, service animal organizations
veterinarian	Provides medical treatment to animals.	Veterinarian's office, farms, aquariums, zoos, stables, pet stores, animal product companies, universities
veterinary technician or veterinary nurse	Works with veterinarians to treat or study animals.	Veterinarian's office, laboratory, university, farm
wildlife rehabilitator	Cares for ill, injured, or orphaned animals until they can be released into the wild. Wildlife rehabilitators require an official license.	Wildlife centers, aquariums, zoos, animal shelters
wildlife biologist	Studies animals and how they interact with their ecosystems.	Universities, government agencies, medical research laboratories, museums, zoos
zookeeper	Cares for captive animals through feeding, training and generally caring for their wellbeing.	Zoos, aquariums, animal refuges, theme parks
zoologist	Studies animals and how they interact with their ecosystems.	Universities, government agencies, medical research laboratories, museums, zoos

WHO DO YOU KNOW?

One of the best recruiting tools for your Project is your own team. **Think about it.** Who do you know? Chances are good that someone knows a professional who works with animals in some way. Ask your team members to think about family, friends, or mentors who work in a job that involves animals.

Refer to the list of professionals on the previous page to help you brainstorm ideas. Think about the people who study, treat, or manage animals. Think about the technology that people use to care for animals. Who makes that technology?

Make a list of people your team might want to interview.

HOW SHOULD YOU ASK?

As a team - talk about your list of professionals and choose one or more who you think could help your team learn about how people interact with animals. Do a little research about each professional. Find out how the person works with this year's theme and think about what questions you might want to ask in an interview.

Next, work with team members to contact the professional you chose. Explain a little about *FIRST*® LEGO® League and what you are researching this season. Tell the professional about the team's goals and ask if they can interview him or her.

WHAT SHOULD YOU ASK?

Have the team prepare a list of questions for the interview. When you think about questions to ask:

- Use the research the team has already done to brainstorm questions about the professional's area of expertise. It's important to ask questions the person can answer.
- Keep the team's Project goal in mind. Ask questions that will help you learn more about your topic and design an innovative solution.
- Keep questions short and specific. The more direct team members can be, the more likely they are to receive a useful answer.
- Do NOT ask the professional to design an innovative solution for your team. The team's solution must be the work of team members. If you already have an innovative solution though, it is ok for the professional to provide feedback on the idea.

At the end of the interview, ask the professional if your team may contact him or her again. They might think of more questions later. Maybe the person would be willing to meet with your team again or give you a tour. Don't be afraid to ask.

And finally, show your team's Gracious Professionalism® during the interview, and remember to thank the professional for his or her time!

WHERE TO LEARN MORE? VISIT http://firstlegoleague.org/challenge#animal-allies

- Find the essential details of the Project in the Challenge.
- Check the Project Updates often. Here *FIRST*® LEGO® League staff will clarify common questions. Updates supersede anything in this Challenge document and will be in effect at tournaments.
- Learn more about how to approach the Project with your team and read tips from experienced Coaches in the Coaches' Handbook:
  http://firstinspires.org/resource-library/fll/coaches-handbook.
- Your team will be assessed in the judging room using a standard rubric. Review the Project judging information and rubric.
- If you are completely new, check out the *FIRST* LEGO League Resource Library for videos, tips, and additional helpful rookie links: http://firstinspires.org/resource-library.

The Robot Game

The Robot Game Rules
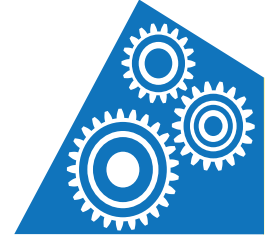
GUIDING PRINCIPLES

GP1 – Gracious Professionalism[®] - You are "Gracious Professionals." You compete hard against problems, while treating all people with respect and kindness. If you joined *FIRST*[®] LEGO[®] League with a main goal of "winning a robotics competition," you're in the wrong place!

GP2 – Interpretation
- **If a detail isn't mentioned, then it doesn't matter.**
- Robot Game text means exactly and only what it plainly says.
- If a word isn't given a game definition, use its common conversational meaning.

GP3 – Benefit of the Doubt - If the Referee (Ref) feels something is a "very tough call," and no one can point to strong text in any particular direction, you get the Benefit Of The Doubt. This good-faith courtesy is not to be used as a strategy.

GP4 - Variability - Our suppliers and volunteers try hard to make all Fields correct and identical, but you should always expect little defects and differences. Top teams design with these in mind. Examples include Border Wall splinters, lighting changes, and Field Mat wrinkles.

GP5 - Information Superiority - If two official facts disagree, or confuse you when read together, here's the order of their authority (with #1 being the strongest):
  #1 = Current Robot Game **UPDATES**
  #2 = **MISSIONS** and **FIELD SETUP**
  #3 = **RULES**
  #4 = **LOCAL HEAD REF** - In unclear situations, local Head Referees may make good-faith decisions after discussion, with Rule GP3 in mind.
- Pictures and video have no authority, except when talked about in #1, #2, or #3.
- Emails and Forum comments have no authority.

DEFINITIONS

D01 - Match - A "Match" is when two teams play opposite each other on two Fields placed north to north.
- Your Robot **LAUNCHES** one or more times from Base and tries as many Missions as possible.
- Matches last 2-1/2 minutes, and the timer never pauses.

D02 - Mission - A "Mission" is an opportunity for the Robot to earn points. Missions are written in the form of requirements.
- Most are **results** that must be visible to the Ref at the **end of the match**.
- Some are **actions** that must be watched/approved by the Ref **as they happen**.
- If a Mission has any "more" requirements, they must all be met, or the whole Mission scores zero.

D03 - Equipment - "Equipment" is everything you bring to a Match for Mission-related activity.

D04 - Robot - Your "Robot" is your LEGO® MINDSTORMS® controller and all the Equipment you've combined with it by hand which is not intended to separate from it, except by hand.

D05 - Mission Model - A "Mission Model" is any LEGO object already at the Field when you get there. Mission Models are not the same as "Equipment."

D06 - Field - The "Field" is the Robot's game environment, consisting of Mission Models on a Mat, surrounded by Border Walls, all on a Table. "Base" is part of the Field. For full details, see Field Setup: http://firstlegoleague.org/challenge#animal-allies.

D07 - Base - "Base" is the space directly above the Field's **larger** quarter-circle region, in the southwest corner. It extends southwest from the outer curved line to each wall (no farther), and has no ceiling. The diagrams below define "Completely In" for Base, but apply for any area.

BASE   "COMPLETELY IN"

"PARTLY IN"   "PARTLY IN"   "PARTLY IN"   "COMPLETELY OUT"
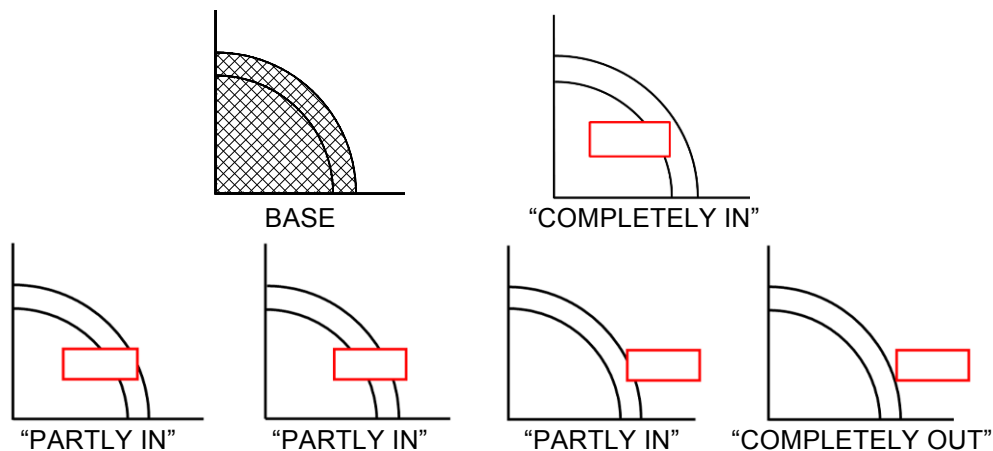
D08 - Launch - Whenever you're done handling the Robot and then you make it go, that's a "Launch."

D09 - Interruption - The next time you interact with the Robot after Launching it, that's an "Interruption."

D10 - Transporting - If the Robot is in contact with something for the obvious purpose of taking it, changing its location, or releasing it, the robot is "Transporting" it.

EQUIPMENT, SOFTWARE, AND PEOPLE

R01 - All Equipment - All Equipment must be made of LEGO-made building parts in original factory condition.
    Except: LEGO string and tubing may be cut shorter.
    Except: Program reminders on paper are okay (off the Field).
   Except: Marker may be used in hidden areas for identification.

R02 - Controllers - You are allowed only **one** individual controller in any particular Match.
- It must exactly match a type shown below (Except: Color).
- All other controllers must be left in the Pit Area for that Match.
- All remote control or data exchange with Robots (including Bluetooth) in the competition area is illegal.
- This rule limits you to only **one individual Robot** in any particular Match.

EV3   NXT   RCX

R03 - Motors - You are allowed up to **four** individual motors in any particular Match.
- Each one must exactly match a type shown below.
- You may include more than one of a type, but again, your grand total may not be greater than FOUR.
- ALL other motors must be left in the Pit Area for that Match, **no exceptions**.

EV3 "LARGE"   EV3 "MEDIUM"   NXT   RCX
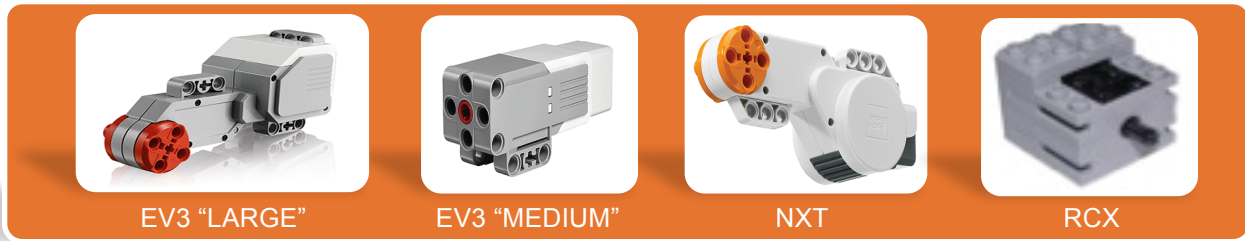
R04 - External Sensors - Use as many external sensors as you like.
- Each one must exactly match a type shown below.
- You may include more than one of each type.

EV3 TOUCH GYRO/ANGLE   EV3 COLOR   EV3 ULTRASONIC   EV3

NXT TOUCH   NXT LIGHT   NXT COLOR   NXT ULTRASONIC

RCX TOUCH   RCX LIGHT   RCX ROTATION

R05 - Other Electric/Electronic Things - No other electric/electronic things are allowed in the competition area for Mission-related activity.
Except: LEGO wires and converter cables are allowed as needed.
Except: Allowable power sources are one controller's power pack or **six** AA batteries.

Robot Game   Page 17

R06 - Non-Electric Elements - Use as many non-electric LEGO-made elements as you like, from any set.
Except: Factory-made wind-up/pull-back "motors" are not allowed.
Except: Additional/duplicate Mission Models are not allowed.

R07 - Software - The Robot may only be programmed using LEGO MINDSTORMS RCX, NXT, EV3, or RoboLab software (any release). No other software is allowed. Patches, add-ons, and new versions of the allowable software from the manufacturers (LEGO and NI) are allowed, but tool kits, including the LabVIEW tool kit, are not allowed.

R08 - Technicians
- Only two team members, called "Technicians," are allowed at the competition Field at once.
  Except: Others may step in for true emergency repairs during the Match, then step away.
- The rest of the team must stand back as directed by tournament officials, with the expectation of fresh Technicians being able to switch places with current Technicians at any time if desired.

PLAY

R09 - Before The Match Timer Starts - After getting to the Field on time, you have at least one minute to prepare. During this special time only, you may also...
- Ask the Ref to be sure a Mission Model or setup is correct.
- Calibrate light/color sensors anywhere you like.

R10 - Handling During the Match
- You are not allowed to interact with any part of the Field that's not COMPLETELY in Base.
  Except: You may Interrupt the Robot any time.
  Except: You may pick up Equipment that **broke** off the Robot **unintentionally**, anywhere, any time.
- You are not allowed to cause anything to move or extend over the Base line, even partly.
  Except: Of course, you may **Launch** the Robot.
  Except: You may move/handle/**Store** things off the Field, any time.
  Except: If something accidentally crosses the Base line, just calmly take it back – no problem.
- Anything the Robot affects (good or bad!) or puts completely outside Base stays as is unless the Robot changes it. Nothing is ever repositioned so you can "try again."

R11 - Mission Model Handling
- You are not allowed to take Mission Models apart, even temporarily.
- If you combine a Mission Model with something (including the Robot), the combination must be loose enough that if asked to do so, you could pick the Mission Model up and nothing else would come with it.

R12 - Storage
- Anything completely in Base may be moved/stored off the Field, but must stay in view of the Ref, on a stand.
- Everything in off-Field Storage "counts" as being completely in Base.

R13 - Launching - A proper Launch (or re-Launch) goes like this:
- Ready Situation

o Your Robot and everything in Base it's about to move or use is arranged by hand as you like, all fitting completely in **Base**.
o The Ref can see that nothing on the Field is moving or being handled.
• Go!
o Reach down and touch a button or signal a sensor to activate a program.

First Launch of the Match – Here, accurate fair timing is needed, so the exact time to Launch is the beginning of the last word/sound in the countdown, such as "Ready, set, **G**O!" or **B**EEEP!

R14 - Interrupting - If you **Interrupt** the Robot, you must stop it immediately, *then calmly pick it up for a re-Launch (*if you intend one). Here's what happens to the Robot and any object it was Transporting, depending on where each was at the time:
• **Robot**
o Completely in Base: Re-Launch
o NOT completely in Base: Re-Launch + Penalty
• **Transported Object**
o Completely in Base: Keep it
o NOT completely in Base: Give it to the Ref

The "Penalty" is described with the **MISSIONS**.

R15 - Stranding - If the **Uninterrupted** Robot loses something it was Transporting, that thing must be allowed to come to rest. Once it does, here's what happens to the Transported object, depending on its rest location...
• **Transported Object**
o Completely in Base: Keep it
o Partly in Base: Give it to the Ref
o Completely outside Base: Leave as is

R16 - Interference
• You are not allowed to negatively affect the other team except as described in a Mission.
• Missions the other team tries but fails because of illegal action by you or your Robot will count for them.

R17 - Field Damage
• If the Robot separates Dual Lock or breaks a Mission Model, Missions obviously made possible or easier by this damage or the action that caused it do not score.

R18 - End of the Match - As the Match ends, everything must be preserved exactly as-is...
• If your Robot is moving, stop it as soon as possible and leave it in place. (Changes after the end don't count.)
• After that, hands off everything until after the Ref has given the okay to reset the table.

R19 - Scoring

- Scoresheet - The Ref discusses what happened and inspects the Field with you, Mission by Mission.
  - ○ If you agree with everything, you sign the sheet, and the scoresheet is final.
  - ○ If you don't agree with something, the Head Ref makes the final decision.
- Impact - Only your **best** score from regular Match play counts toward awards/advancement. Playoffs, if held, are just for extra fun.
- Ties - Ties are broken using second, then third best scores. If still not settled, tournament officials decide what to do.

SERIOUS CHANGES FOR 2016 (All are the effects of simplifications.):

- There is no "Safety" region now. The whole quarter-circle region is all Base.
  The inner curved line is meaningless now.
- The ceiling of Base has been removed, so there is no limit on how tall a Launching Robot may be.
- Transported objects partly in Base when the Robot is Interrupted are always given to the Ref, out of play.
- Stranded objects partly in Base are always given to the Ref, out of play.
- On-Field Storage outside Base no longer allowed.
- If the Robot is Interrupted Transporting an object not completely in Base, the Ref now keeps that object no matter what.
- There is no "Junk" penalty.
- Local Head Referee responsibility is enhanced.
- The "Benefit Of The Doubt" rule is strengthened.

The Robot Game Missions

Do we need animals, or do they need us? Answer: YES! This Robot Game showcases just a fraction of our wonderful story with animals. As you work on the Missions, pay attention to the many ways innovation and technology have enabled humans and animals to exchange learning, friendship, help, daily needs, protection, amusement, and love… As you'll see, there are many fun problems left to solve!

M01 - SHARK SHIPMENT - In their usual environments, animals are very resilient. But in strange environments, they need a lot of care. As we ship our Bonnet-Head Shark in an aircraft, she needs impact avoidance, specific diet, clean water at proper pressure and temperature, and medical care along the way! She must not be upset.

Move the Shark to her new home not touching her tank's walls.

EXACT SCORING REQUIREMENT OPTIONS:

- **Visible at the end of the match**:
  - o Tank and Shark are completely in Target 1: 7 Points,
    OR Target 2: 10 Points
- **Bonus** (Added only if a Target score is earned): Shark is touching only the tank floor and no wall: 20 Points
- **More**: After Launch for this Mission, nothing is ever allowed to touch the Shark except the Tank.

TARGET 1   TARGET 2

M02 - SERVICE DOG ACTION - Visually impaired people become experts at being able to tell when they are about to cross a road, but it's harder to tell when a vehicle is coming. So that part of the job is given to the Service Dog! If a vehicle is coming, the Service Dog will stop and sit.

Drive past the visually impaired man, and the dog will do her job.

EXACT SCORING REQUIREMENTS:
- **Visible at the end of the match**:
  - o The Warning Fence is down: 15 Points
- **More**: The Fence must be down because the Robot completely crossed it from the west, after traveling between the Barriers: Y/N

FENCE DOWN

M03 - ANIMAL CONSERVATION - Facilities often exchange animals for behavioral study, mating, health, efficiency, friendship, and the visiting public. But imagine how difficult some animals might be to transport!

Work with the other team to unite identical animals. Every pair united will score for BOTH teams, no matter who worked on that union.

- Before the Match starts, hand-place your choice of **one** animal in your tray of the Animal Conservation Mission Model. The placement must match one of these *options:
  - o Reindeer facing west
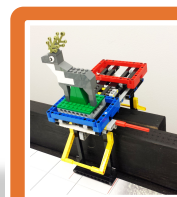
If placing an animal other than the Reindeer, put the Reindeer on that animal's mark, facing west.

- o Gorilla facing south
- o Bat facing south
- o Flamingo facing east
- o Frogs facing south & west
- o If placing another animal other than Reindeer, put Reindeer on that animal's mark facing west
- During the Match, participating Robots make the trays switch places. A switch is officially successful when the red axle causes the system to stop. Robots then have the option of removing the received animal and replacing it with a different animal for switching. The Referee resets the red axle.

EXACT SCORING REQUIREMENTS:
- **Visible at the end of the match:**
  - o Two identical animals are completely on the same **Side: 20 Points **per pair**
  - o Both teams get points for **all** pairs.
- **More**: Each pair must be created through rotation of the Animal Conservation Mission Model: Y/N

*The five optional animals listed in this mission are the only ones allowed for exchange.
**For M03, a "Side" is anywhere completely south of the symmetric line between Fields, including that Field's Storage areas.

M04 - FEEDING - The responsibility, patience, and organizational skill shown by animal caregivers is unbelievable! Multiple types of animals all need their own exact rations of rare, pure, or exotic foods, with short shelf-lives, at exact temperatures, at all hours of the day or night. In some ways, it can make taking care of human babies look easy.

Deliver food from the Refrigerator to Target Animal Areas.

ANIMAL AREAS FOR REFRIGERATOR FOOD (Areas do not include the rectangles)

EXACT SCORING REQUIREMENTS:
- **Visible at the end of the match**:
  - o A piece of Food is completely in a Target Area: 10 Points (Each Piece)
- **More**: If multiple pieces of Food are in one area, all must match each other: Y/N

M05 - BIOMIMICRY - Over many years, animals have solved some tough problems and developed some amazing abilities, so it is wise of us to learn what we can from them. For example, when climbing a smooth, featureless surface, the Gecko demonstrates a fascinating mastery of nanotechnology.

Test our ability to mimic the Gecko's "stickiness" by placing the White (mechanical) Gecko on the Biomimicry Wall, and/or by seeing if the Robot itself can get onto the wall.
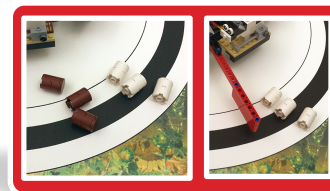
EXACT SCORING REQUIREMENTS:
- **Visible at the end of the match:** The Biomimicry Wall completely supports:
  - o All the weight of the White Gecko: 15 Points
  - o All the weight of the Robot: 32 Points
- **More**: For an object to score, no part of it may be in contact with anything but the Biomimicry Wall and/or Green Gecko, except two scoring objects may be in contact with each other: Y/N

M06 - MILKING AUTOMATION - For hundreds of years, people have designed innovative machines to make work easier. The more work there is to do, the more helpful a machine can be - even if the work is milking! *In the Milk Mission, why are we paying attention to Manure? Answer: Manure is a type of feces, and in real life, animals routinely produce feces. When you think of animals as *interesting* or *cuddly*, don't forget about the smell of a farm, the goo on car windshields, or what a puppy can do to your carpet. Some of us laugh at the idea of manure, and some of us say "Yuck," but for animal handlers, manure will always be a serious challenge.

Guide the cow into the machine, then spin the machine until Milk comes out. If you spin too far, *Manure also comes out!
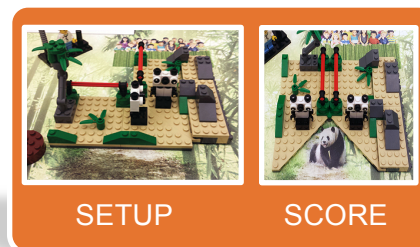
EXACT SCORING REQUIREMENTS:
• **Visible at the end of the match:**
  o Milk **and** Manure have all rolled out: 15 Points
  o Milk has all rolled out, but **not** Manure: 20 Points
• **More**: The Robot's only movement of the Milk and/or Manure came by moving the red lever: Y/N

M07 - PANDA RELEASE - After some animals are cared for, studied, and respected, they are returned to their natural habitat. That's usually the best thing for the environment, the animal's population, and the animal itself.

Convert the Panda's scene from facility care and observation to open wilderness.

EXACT SCORING REQUIREMENT:
• **Visible at the end of the match:**
  o The slider looks fully open clockwise: 10 Points

SETUP   SCORE

M08 - CAMERA RECOVERY - Some modern on-board cameras are small and light enough to attach directly to an animal. These cameras can give us amazing new insights into the animal's life, but they do need to come back to the lab sometimes, for maintenance and data retrieval.

Go get the camera and bring it to Base.

EXACT SCORING REQUIREMENTS:
• **Visible at the end of the match:**
  o The Camera is completely in Base: 15 Points

M09 - TRAINING AND RESEARCH - A career working with animals can be fun, dangerous, interesting, gross, and rewarding, all at once. A Trainer spends thousands of hours teaching animals entertaining and helpful behaviors. A Zoologist might find herself helping a trainer one moment, and analyzing feces the next (feces contains information about an animal's habits and health).

Move the Dog & Trainer, Zoologist, and/or Manure Samples to the Training & Research Area.

EXACT SCORING REQUIREMENTS/OPTIONS:
• **Visible at the end of the match:**
  o The Dog & Trainer are completely in the Training & Research Area: 12 Points
  o The Zoologist is completely in the Training & Research Area: 15 Points

o Manure *Samples are completely in the Training & Research Area: 5 Points Each
- **More**: Only one Manure Sample may be Transported at a time: Y/N

*Only disc-shaped Manure counts as Samples.

M10 - BEE KEEPING - We quickly think of honey and flowers (and maybe pain!) when we see a honey bee, but we shouldn't forget that an unbelievable amount of the world's food supply depends on bee populations. Since beekeepers help bees help humans…

Place the Bee on the Beehive and get the Honey out.

EXACT SCORING REQUIREMENTS/OPTIONS:
- **Visible at the end of the match:**
   o The Bee is on the Beehive and there is no Honey in the Beehive: 12 Points
      OR
   o The Bee is on the Beehive and the Honey is completely in Base:15 Points

TRAINING & RESEARCH AREA
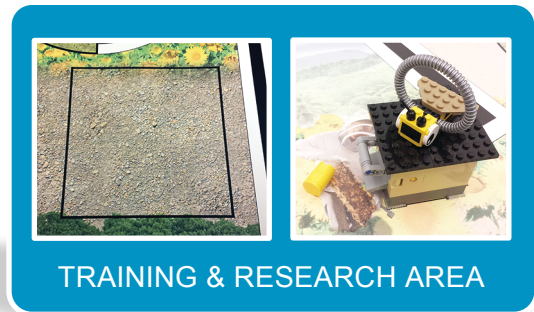
M11 - PROSTHESIS - The technology and focused dedication needed to provide a prosthesis is not only for humans.

Fit the Prosthesis where the legs of the Pet (Our Little Friend) should be, and send the Pet to its place on the farm.

EXACT SCORING REQUIREMENTS/OPTIONS:
- **Visible at the end of the match:**
   o The Prosthesis is fitted to the Pet AND not held by the Ref: 9 Points
      OR
   o The Prosthesis is fitted to the Pet AND the Pet is completely in its Farm Target: 15 Points

FITTED   FARM TARGET

M12 - SEAL IN BASE
- **Visible at the end of the match:**
   o The Seal is completely in Base and not broken: 1 Point

M13 - MILK IN BASE
- **Visible at the end of the match:**
   o All three Milk are completely in Base: 1 Point

M14 - MILK ON RAMP
- **Visible at the end of the match:**
   o Option 1: 2 Points
      ▪ All three Milk are completely supported by the Ramp

   o Option 2: 3 Points
      ▪ All three Milk are completely supported by the Ramp,
      ▪ AND they're the only things supported by the Ramp,
      ▪ AND they're the only things touching the Ramp

- o Option 3: 4 Points
  - ▪ All three Milk are completely supported by the Ramp,
  - ▪ AND they're the only things supported by the Ramp,
  - ▪ AND they're the only things touching the Ramp,
  - ▪ AND they're all standing

M15 - ALL SAMPLES
- **Visible at the end of the match:**
  - o All twelve Manure Samples are completely in the Training And Research Area: 5 Points Added To M09

PENALTIES - Before the match starts, the Ref removes five Manure Samples from Base, and holds on to them, leaving five still there. If you Interrupt the Robot, the Ref places one of the removed Samples in the white triangle, in the southeast, as a permanent/untouchable Interruption Penalty. You can get up to five such penalties, worth Minus 6 Points Each

Robot Design Executive Summary

An "executive summary" is often used by engineers to briefly outline the key elements of a product or project. The purpose of the Robot Design Executive Summary (RDES) is to give the Robot Design Judges a quick overview of your team's robot and all that it can do.
Unlike the Core Values Poster, teams do not need to create a poster or written material for the RDES. However, if the team would like to share pictures of the design process, records of strategy sessions, or examples of programming (either printed or on a laptop), the RDES presentation is an appropriate time.

> Some regions require all teams to prepare a Robot Design Executive Summary, while others do not. Either way, the RDES is a great tool to help your team organize their thoughts about the robot and the design process they used. Check with your tournament organizer to see if your team is expected to present your RDES in the Robot Design judging session.

Have your team prepare a short presentation (no longer than four (4) minutes) covering the elements below:

1. **Robot Facts**: Share a little bit about your robot, such as the number and type of sensors, drivetrain details, number of parts, and the number of attachments. The Judges also like to know what programming language your team used, the number of programs, and the Robot Game mission where your team had the most success.
2. **Design Details**:
   a. **Fun**: Describe the most fun or interesting part of robot design as well as the most challenging parts. If your team has a fun story about your robot please feel free to share.
   b. **Strategy**: Explain your team's strategy and reasoning for choosing and accomplishing missions. Talk a little bit about how successful the robot was in completing the missions that were chosen.
   c. **Design Process**: Describe how your team designed their robot and what process they used to make improvements to the design over time. Briefly share how different team members contributed to the design.

d. **Mechanical Design**: Explain the robot's basic structure. Explain to the Judges how the robot moves (drivetrain), what attachments and mechanisms it uses to operate or complete missions, and how your team makes sure it is easy to add/remove attachments.

e. **Programming**: Describe how your team programmed the robot to ensure consistent results. Explain how the team organized and documented programs. Mention if the programs use sensors to know the location of the robot on the field.

f. **Innovation**: Describe any features of the robot's design that the team feels are special or clever.

3. **Trial Run**: Run the robot briefly to demonstrate how it completes the mission(s) of your team's choice. Please do not do an entire robot round. The Judges need time to ask questions after the RDES.

WHERE TO LEARN MORE? VISIT http://firstlegoleague.org/challenge#animal-allies

- Find the essential details of the Robot Game in the Challenge.
- Check the Robot Game Updates often. Here *FIRST*® LEGO® League staff will clarify common questions. Updates supersede anything in this Challenge document and will be in effect at tournaments.
- Your team will be assessed in the judging room using a standard rubric. Review the Robot Design judging information and rubric.
- Your team will also compete in at least three Robot Performance matches. Learn more about Robot Performance, how to approach the Robot Game with your team, and tips from experienced Coaches in the Coaches' Handbook: http://firstinspires.org/resource-library/fll/coaches-handbook.
- If you are completely new, check out the *FIRST* LEGO League Resource Library for videos, tips, and additional helpful rookie links: http://firstinspires.org/resource-library.

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