FIRST® LEGO® League

2010 FLL CHALLENGE

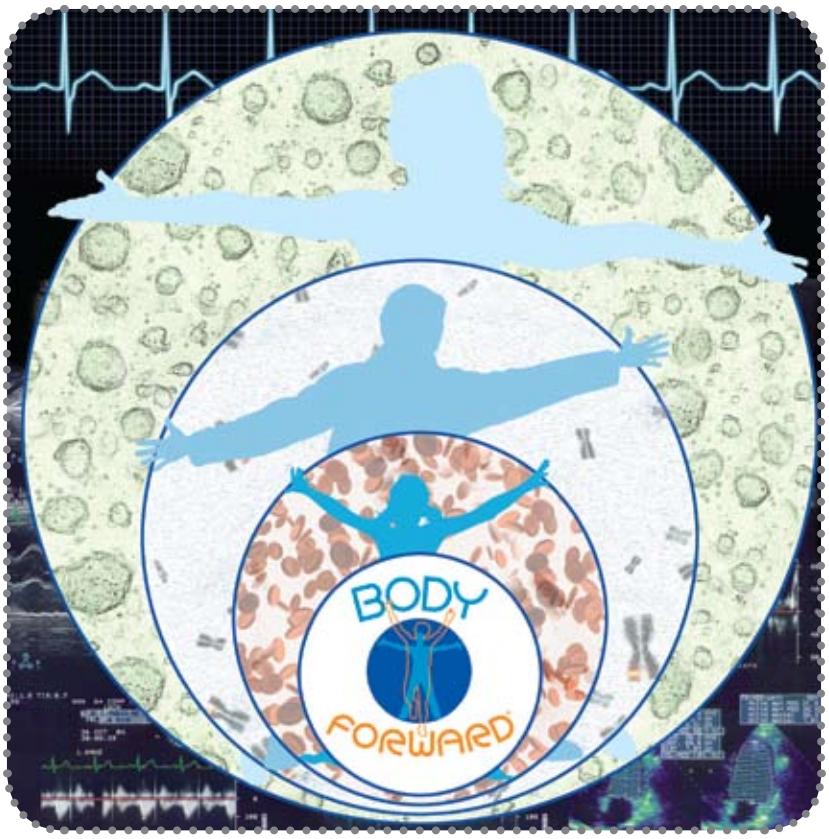


TABLE OF CONTENTS

FIRST® LEGO® League

2010 FLL CHALLENGE

PROJECT

THINK ABOUT IT

What do chicken eggs, caterpillar cells, self-repairing robots, and dirt have in common? Biomedical Engineering! Each and every day, your team benefits from the work of scientists, engineers, and doctors. That work protects you from disease, helps your injuries heal, cures your sicknesses, and allows you to lead healthier lives. Did you know that scientists are studying caterpillar cells and using them instead of chicken eggs to make vaccines faster? Or that dirt from South America might just cure viruses? Or that the work on newer, faster computer chips is leading to artificial limbs that can feel hot and cold and move more naturally? Did you know that Biomedical Engineering goes back to ancient times? Archeologists in Egypt found a mummy with an artificial toe that is 3,000 years old! 5,000 year old skulls show evidence of brain surgery!

Now, consider. Your body is made up of a lot of parts —some so big (like skin, arms, and legs) you can't miss them; some so small (like platelets, cells, and neurons) you'll never see them with the naked eye. What happens when one of those parts is damaged? Who fixes them? Where do they get the tools they use? What happens when something (germs, accidents, pollution, junk food) attacks those parts? How can you protect yourself? Who invented things like microscopes? laboratory equipment? artificial arms and legs? tongue depressors? Band-Aids?

Think about something as simple as breathing. But breathing is not so simple for people with asthma or influenza. It is not so simple for older people whose lungs are wearing out. They need help just to get enough air. Where would those people be without the doctors and scientists who figured out that they needed more oxygen? Could they live as long without the physicists and mechanical engineers who figured out how to put oxygen in tanks? Would they be able to travel, shop, or play outside without the chemists and mineralogists who figured out how to separate oxygen from plain air? How much harder would their lives be without the electrical engineers, mechanical engineers, and programmers who figured out how make that filter small and light enough to carry. What had to happen to make that filter run for hours and hours on batteries?

Your challenge this season is to explore the cutting-edge world of Biomedical Engineering to discover innovative ways to repair injuries; overcome illnesses and disabilities; and build healthier, stronger bodies. Once you know how scientists, engineers, and doctors work together to find solutions, do some research. What kinds of problems keep people from leading happy and healthy lives? How could your team help solve one of those problems?

IDENTIFY A PROBLEM

Begin your project by creating a list of your body parts, functions, or systems. Think about the things that could go wrong with each one, and ways to protect, repair, or make them stronger. Be creative. Be silly. Be serious. Think about everything that makes you—YOU!

Once your list is complete, pick one body part, function (like hearing or breathing), or system (like circulation with the heart, veins, arteries, capillaries, and blood all working together) and learn more about it!

Whether your team chooses an arm, ear, leg, brain, nerve, heart, gene, tooth, lung, DNA strand, skin cell, eye, muscle, nose, bone, stomach, your hands or feet, or a group of parts that work together…it's time to research. How does your body part, function or system work with other body parts, functions, or systems to keep you healthy? What dangers does it face? What kinds of scientists, doctors, and engineers are studying that part, function, or system? Find out about one of the people who is working to make your team's body part, function, or system stronger and healthier, to fix it when it's injured, or to heal it when it's sick. Search out the problems and choose one to solve. Look at reports. Read books and magazines. Browse Web sites. Conduct a survey. Check with experts who work in and around your community. Use any research tools you have available. Be prepared to share your information sources.

CREATE AN INNOVATIVE SOLUTION

Choose one of the problems associated with the body part, function or system your team has chosen to research and suggest a solution—a new idea or an improvement on something already being done. What is being done to fix the problem? What could be done? What will it take to make your team's solution happen? How will your solution help people live happier and healthier lives? A great solution might take all the imagination and ingenuity your team can muster. It might seem so obvious that you wonder why the problem even exists.

Decide where your solution fits:

- Body—Repaired
- Body—Healed
- Body—Improved

And remember, the most important thing is to have fun.

SHARE WITH OTHERS

Now, tell others about the problem you researched, and exactly how your solution can help. You choose how to share what you've learned. Here are some ideas for sharing. Give a talk for parents. Create a website. Perform a skit. Make a comic book. Rap. Create a poster. Pass out flyers. Write a poem, song, or story. Present your research and solution to lawmakers, doctors, engineers, or groups who already help with your problem. Your presentation can be simple or elaborate, serious or designed to make people laugh while they learn. Your ideas can change the world!

PRESENT YOUR SOLUTION AT A TOURNAMENT

To be eligible for project awards you must have a live presentation that:

- Describes your body part, function, or system, the problem, and your team's innovative solution
- Identifies at least one scientist, engineer, or doctor who is working on the problem and tells about them
- Shows that your team did the research and tells about the books, magazines, websites, reports, and other resources you used to learn about your problem and those working on it
- Tell how you shared your research findings with others
- Can be set up and presented in 5 minutes or less
- You are responsible for bringing any multimedia equipment you need for your presentation with you to the tournament. (Please check with your tournament organizer to see what equipment can be used on site.)

Your presentation can include posters, slide shows, models, multimedia clips, your research materials—you are limited only by your team's creativity. Remember, you want to leave a lasting impression and you must have at least one live presenter.

NEED HELP GETTING STARTED?

The 2010 Body Forward FLL Coaches' Handbook contains more information about *FIRST* LEGO® League, the Body Forward Challenge, tournaments, awards, and scoring. Be sure to look at The Project rubric on page 106 and The Project Chapter on page 48.

Information and resources are also available online at http://www.firstlegoleague.org.

If you have more questions, e-mail fllprojects@usfirst.org for Project support.

FIRST® LEGO® League

2010 FLL CHALLENGE

ROBOT GAME – FIELD SETUP

OVERVIEW

- The field is where the Robot Game takes place.
- It consists of a field mat, on a table, with mission models arranged on top.
- The field mat and the LEGO pieces for building the mission models are part of your Field Setup Kit.
- The instructions for building the mission models are on a CD, in the same box as the LEGO pieces.
- The instructions for how to build the table and how to arrange everything on it are here…

TABLE CONSTRUCTION

The Robot Game takes place on a specially designed table, so you'll need to build one to practice on if you don't already have access to one. With safety, weight, height, and cost in mind, a simple design is offered here, but as long as your surface is smooth, and your border walls are located properly, how you build the understructure is up to you. The construction is simple, but does require some wood-working skills.

At a tournament, two tables are placed back to back, but you only operate on one table, so you only need to build one table to practice on. Since a tournament setup has a double wall at the interactive area where the two tables meet, practice tables need an extra wall of type **B** on the corresponding side. So here are the instructions for building one "half-table" including a double north wall:

MATERIALS

Material	Quantity
Field Setup Kit (mission model LEGO elements, mat, CD, Dual Lock)	1
sanded plywood (or other very smooth board) 96" X 48" X 3/8" or thicker = 2438mm X 1219mm X 10mm or thicker	1
two-by-four, 8' (actual cross-section = 1-1/2" by 3-1/2") = long board, 2438mm X 38mm X 89mm	4
two-by-three, 8' (actual cross-section = 1-1/2" by 2-1/2") = long board, 2438mm X 38mm X 64mm)	2
flat black paint	1 pt. (half liter) or spray can
coarse drywall screws, 6 X 2-1/2" = coarse drywall screws, ~64mm long	1/2 lb. or 227g
saw horses, about 24" high and 36" wide = 610mm high and 914mm wide	2

PARTS

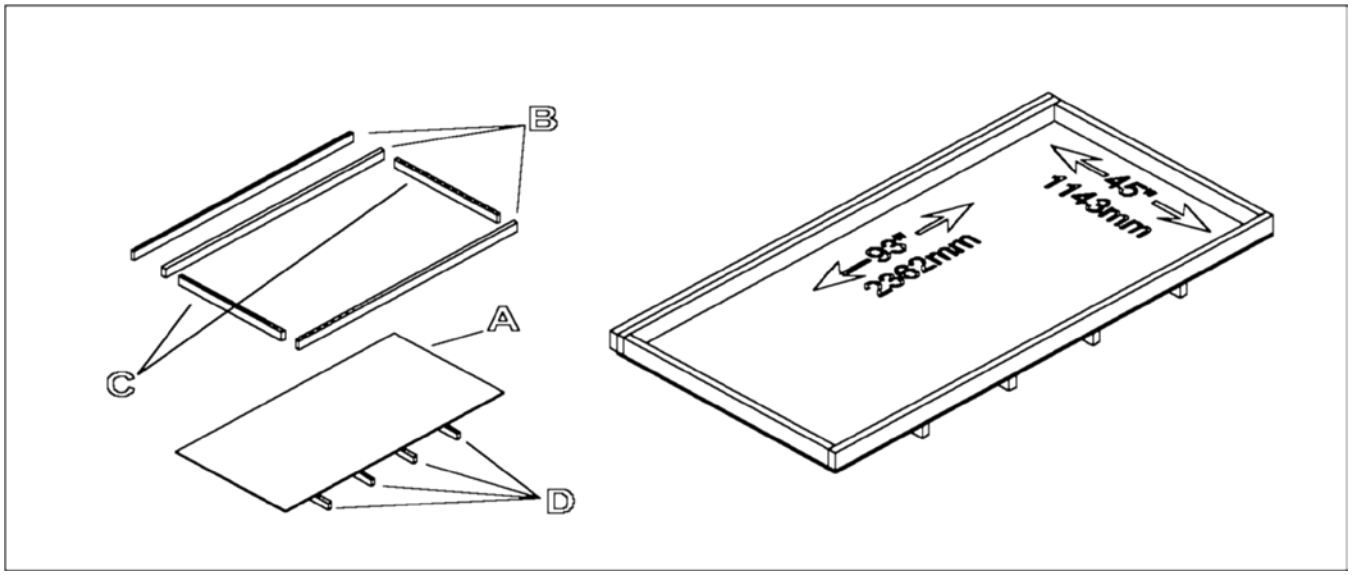
Part	Make From	Dimensions	Paint	Quantity
table surface (**A**)	Plywood	96" X 48" 2438mm X 1219mm	no	1
long border wall (**B**)	two-by-four long board	96"2438mm	yes	3
short border wall (**C**)	two-by-four	45" 1143mm	yes	2
stiffener (**D**)	two-by-three	48" 1219mm	no	4
saw horse	purchase	H ª 24" W ª 36" 610mm 914mm	no	2

ASSEMBLY

Step 1 - Determine which face of the plywood (**A**) is least smooth, and consider that the bottom face. On the bottom face, locate, clamp, and screw on the stiffeners (**D**) (about every 18 inches). Be sure screw head tops are flush. Sand any splinters.

Step 2 - On the top face of the plywood, locate, clamp, and screw on the border walls (**B**,**C**) around the top perimeter. The wall-to-wall dimensions must measure 93±1/8" by 45±1/8" (2362±3mm by 1143±3mm).

Step 3 - With the help of another person, place this table top on short saw horses (or milk crates, or anything else short and solid).



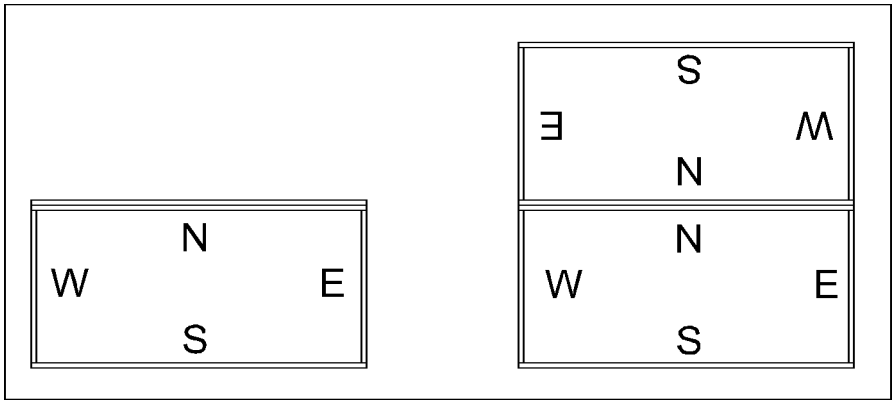
FIELD MAT PLACEMENT

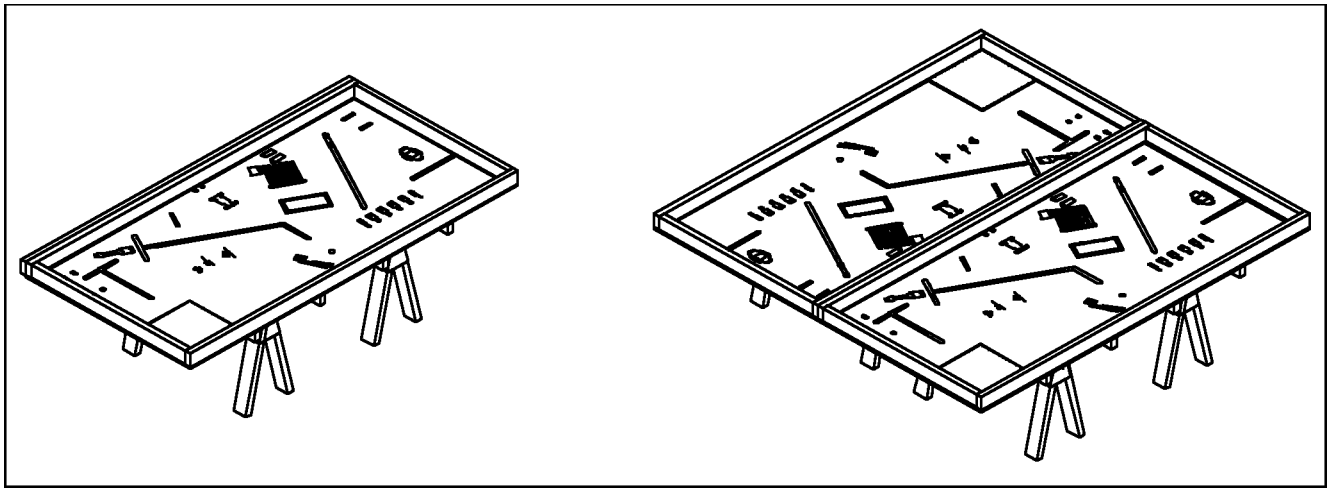
Step 1 - Vacuum the table top. Even the tiniest particle under the mat can give the robot trouble. After vacuuming, run your hand over the surface and sand or file down any protruding imperfections you find. Then vacuum again.

Step 2 - On the vacuumed surface (never unroll the mat in an area where it could pick up particles), unroll the mat so the image is up and its north edge is near the north/double border wall (note the location of the double wall in each table sketch below).

Step 3 - The mat is smaller than the playing surface by design. Slide and align it so that there is no gap between the south edge of the mat and the south border wall. Center the mat in the east-west direction (look for equal gaps at left and right).

Step 4 - With help from others, pull the mat at opposite ends and massage out any waviness away from the center and re-check the requirement of Step 3. It is expected that some waviness will persist, but that should relax over time. Some teams use a hair dryer to speed the relaxation of the waviness.





MISSION MODEL CONSTRUCTION

Build the mission models - Use the LEGO elements and instruction CD from your Field Setup Kit. It should take a single person between two and three hours to do this, so it's best done in a work party. If there are any team members with little or no experience building with LEGO elements, mission model construction is a great way to learn. This step is also a nice time for new team members to get acquainted with each other.

MISSION MODEL ARRANGEMENT

DUAL LOCK

For models where "Dual Lock Needed" appears in the mission model details below, that means the model needs to be secured to the mat during use. The connection is made using the re-usable fastening material from 3M called Dual Lock, which comes in the flat clear bag with the LEGO elements in your Field Setup Kit. Dual Lock is designed to stick or "lock" to itself when two faces of it are pressed together, but you can unlock it too, for ease of transport and storage. The application process for the Dual Lock is only needed once. Later, the models can simply be locked onto the mat or unlocked. To apply Dual Lock:

Step 1 - Stick one square, adhesive side down, on each box you see on the mat with an "X" in it.

Step 2 - Press a second square on top of each of those, "Locking" them on, adhesive side up. TIP: Instead of using your finger, use a bit of the wax paper the squares came on.

Step 3 - Lower the model onto the squares.

CAUTION - Be sure to place each square precisely on its box, and each model precisely over its marks.

CAUTION - When pressing a model down, press down on its lowest solid structure instead of crushing the whole model. Pull on that same structure if you later need to separate the model from the mat.

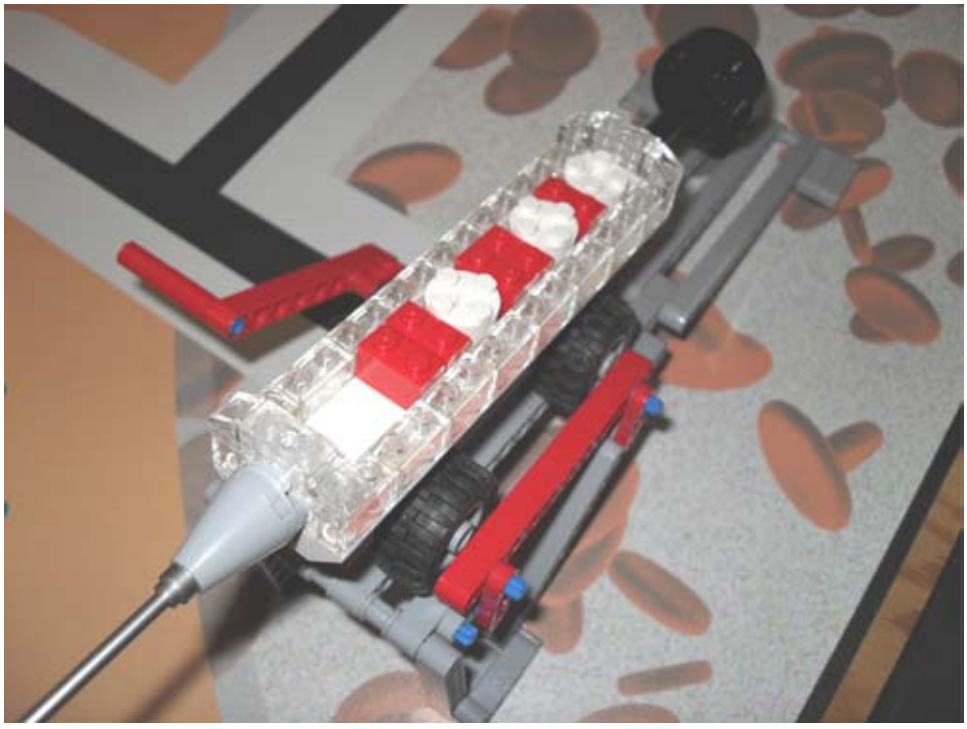
TIP: For large/flexible models, apply only one or two sets at a time.

MODEL DETAILS

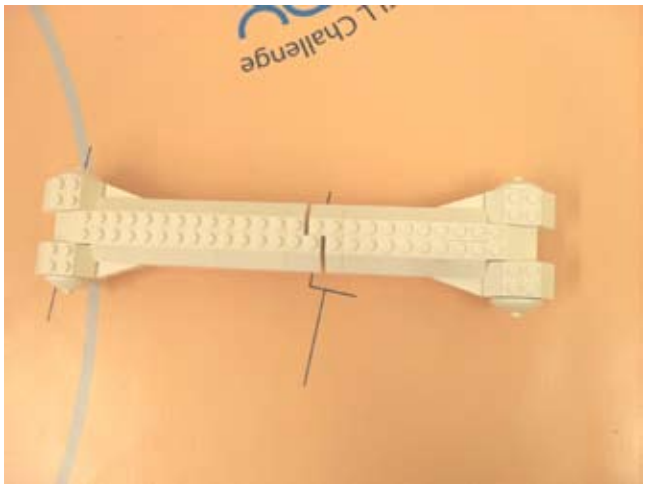
Artery - Dual Lock Needed - Position this model perfectly on its mark at the northwest of the field.

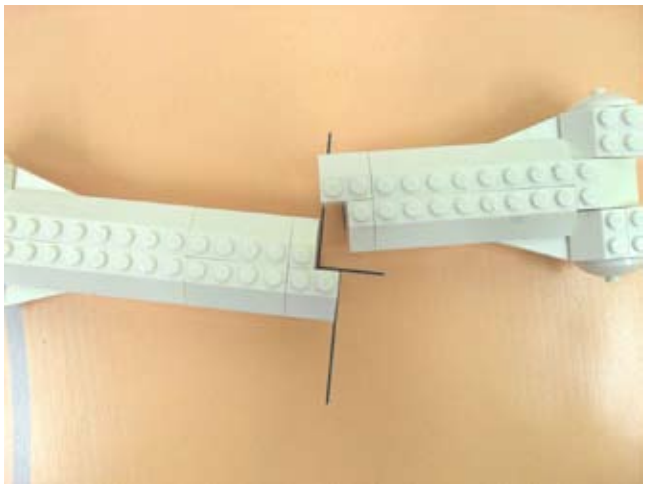
Ramp - Dual Lock Needed - Position this model perfectly on its mark at the northwest of the field, with the low end toward Base. There are no other instructions or cautions for it.

Syringe - (NO Dual Lock Needed) - Place red and white blood cells in the order shown below (from the low end: white, red, white, two red, white, two red, then 2x3 open space). Then lift the ramp's lever as far as it will go. The park the syringe at the high end of the ramp, so the red stopper keeps the syringe from rolling. Then be sure the west wheels are both touching the red railing. Be sure to tighten the syringe's body pieces once in a while, especially the needle.

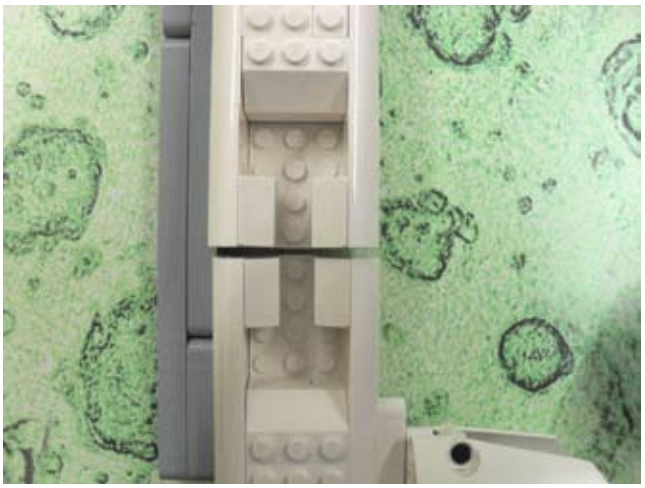


Small Bone - Dual Lock Needed - Position the smaller (west) side part of this model perfectly on its mark at the west center. Then position the bigger (east) side over its mark, and press it down such that there's a 1/16" in (1.5 mm) gap between the two parts. Set position is with the east part angled to line up with the angled lines under it.





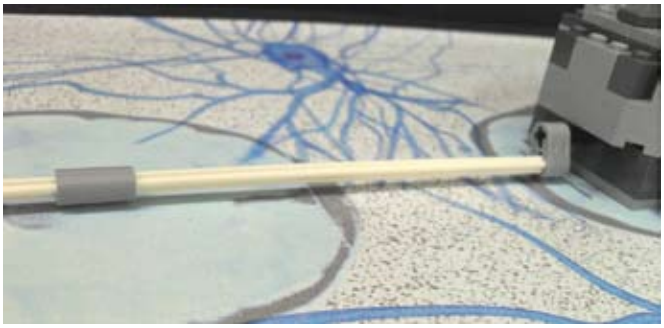
Large Bone - Dual Lock Needed - (for the big part, but not the small part) - Position the bigger part of this model perfectly on its mark at south center. The set position is with the smaller part positioned as shown, with both parts pressed against the gray rail for alignment, and a 1/16" in (1.5 mm) gap between them. Place the blue ball on the black ring, near the foot.



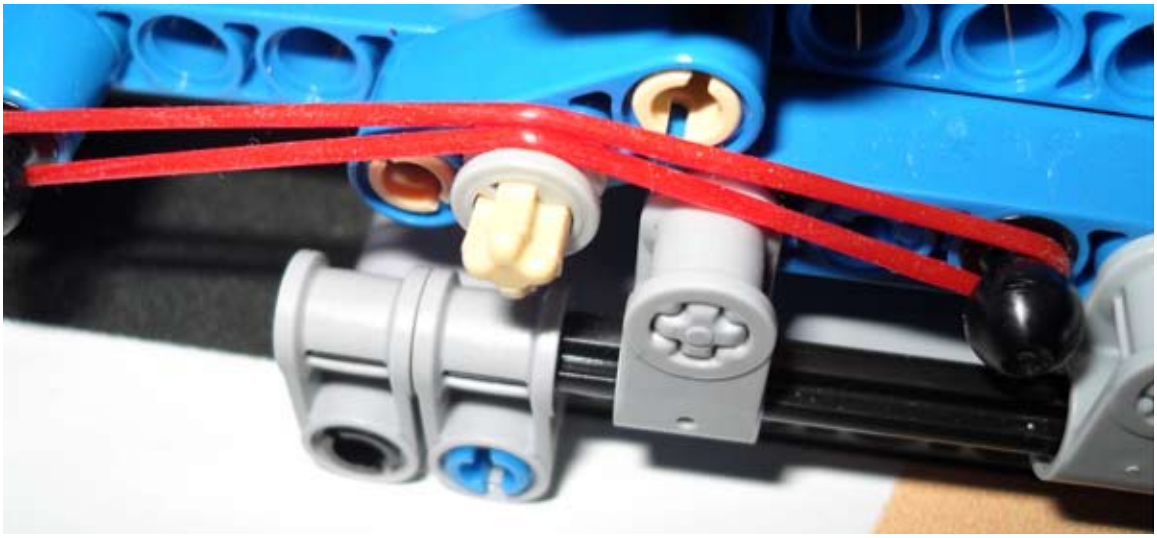
Goal - Dual Lock Needed - Position this model perfectly on its mark at the field's center, with the green strip facing south southwest.

Tissue Areas (Bad and Good Cells) - Dual Lock Needed - Position this model perfectly on its mark at southeast center. The set position is with all panels vertical and each randomly flipped showing white or black. Exception: You will never encounter a setup with all black facing north. This model is set while the robot is active, outside Base. This way you never know what the combination is while the robot's in Base.

Brain And Door - Dual Lock Needed - Position this model perfectly on its mark at the east. Be sure the axle connecting the brain to the door runs parallel with the ground. Set position is with the door all the way closed.



Pressure Tester - Dual Lock Needed - Position this model perfectly on its mark at the northeast. Set position is with the wheel weight all the way down. Be sure the rubber belt runs only in the groove of the gray half-bush (tiny pulley). The belt must not be allowed to rub on the blue beams nor the tan cross-axle. The more friction there is in this model, the easier the mission seems - so be sure you're practicing with a properly maintained model, because they're likely to be correct at tournaments.

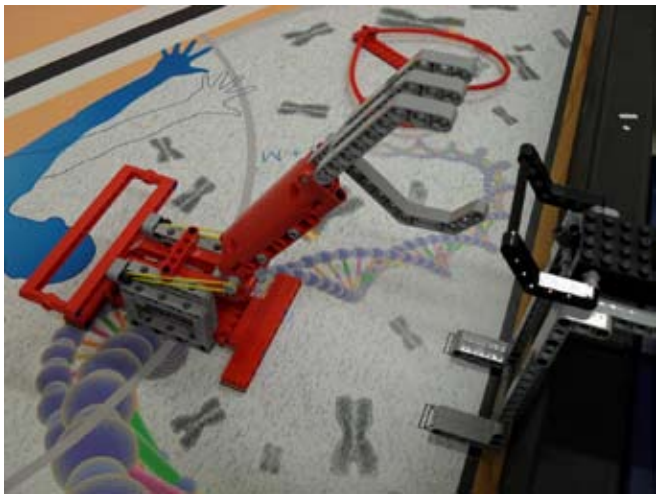


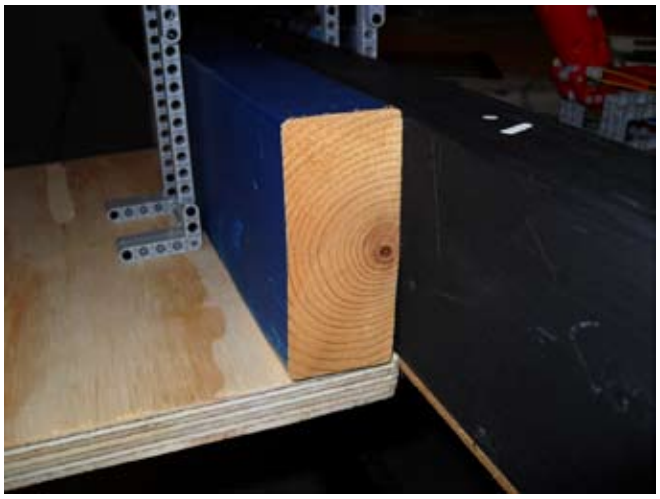
Doctor And Patient - (No Dual Lock Needed) - Position the doctor on the center of the directional compass at the northwest, sitting, looking toward Base. Position the patient on the nucleus of the west-most nerve cell, sitting, looking west. There is no set position for the people's arms, and the doctor's case may or may not be present. Each person's hair must look great.

Medicine Dispenser And Container - Dual Lock Needed (for the dispenser, but not the container) - Position these models perfectly on their marks at the northeast center, with the dispenser's black panel facing east southeast. Set position is with the black panel all the way out, and with medicine arranged in columns. The east column pink, center column white, and west column blue. The medicine does not need to be aligned to itself, or to the dispenser, or crowded in any direction, as long as it all fits reliably on its shelf.

Mechanical Hand - Dual Lock Needed - Position this model perfectly on its mark at the north center, with the hand facing north. Set position is with the hand low and pulled back. It's easiest to set the hand while the patent is not set. Push the arm's base (red forearm) as far north as it will go, then rotate the arm toward the mat as far as it will go. Finally, without letting the arm rotate, slide it south as far as it will go.

Patent - Dual Lock Needed - This model rests half on your field and half on the other team's field. If you only have one field to practice on (most teams only have one), that means two of this model's feet will dangle loosely in the air unless you build something for those feet to rest on. For the gray frame, position the two feet on your field on their marks, perfectly east vs. west, but it's okay and expected if the north vs. south placement isn't exactly on the marks. The hand will grab the patent from a variety of distances. Then place the patent in the holder.





Heart - Dual Lock Needed - Position this model perfectly on its mark at the north west center, with the point facing south southwest.

Remaining Models - (No Dual Lock Needed) - Place both bionic eyes, the stent, three red blood cells, the pace maker, the cast, the biomedical engineer, the cardiac patch, and the bone bridge anywhere in Base, or in your team supplied box in view of the referee.

FIELD MAINTENANCE

- Border Walls - Remove any obvious splinters, and cover any obvious holes.
- Field Mat - Make sure the mat touches the south border wall, and is centered east to west. Avoid cleaning the mat with anything that will leave a residue. Any residue, sticky or slippery, will affect the robot's performance compared to a new mat (many tournaments use new mats). Use a vacuum and/or damp cloth for dust and debris (above and below the mat). To get marks off, try a white-plastic pencil eraser. When moving the mat for transport and storage, be sure not to let it bend into a sharp kink point, which could affect the robot's movement. Tournaments using new mats should unroll the mats as far in advance of the tournament day as possible. For control of extreme curl at the east or west edges of the mat, tape is allowed, with a maximum of $^{1}/_{4}$" (6 mm) overlap. Foam tape is not allowed.
- Mission Models - Keep the models in original condition by straightening and tightening solid connections often. Ensure that spinning axles spin freely by checking for end-to-end play and replacing any that are bent.

FIRST® LEGO® League

2010 FLL CHALLENGE

ROBOT GAME – RULES

1 - READ EVERYTHING - All else held equal, experts on the four main documents of the Robot Game do better and have more fun. Read these well, and come back to them often: Field Setup, Missions, Rules, Rulings.

2 - PURPOSE

- Gain interest in science, technology, engineering, and innovation, in a team environment.
- Have fun pushing yourself.

3 - GRACIOUS PROFESSIONALISM

- You are "Gracious Professionals." You are competing hard against PROBLEMS, while treating PEOPLE with respect and kindness - people from your own team as well people from other teams.
- You build onto other people's ideas instead of resisting or defeating them.

4 - PARTICIPATION

- The maximum allowable team size is ten members, not including coaches and mentors.
- See the *FIRST* LEGO League Coaches' Handbook for allowable ages.
- At the tournament, only TWO team members at a time are allowed right up at the competition table except during repair emergencies.
- The rest of the team must stay back from the table, but close enough for different members to tag in or out as desired at any time. Specific positioning is decided by the tournament officials.

5 - INTERPRETATION

- Robot game text means exactly and only what it says, so it should be taken literally whenever possible.
- Do not interpret text based on your assumption about intent, or on how a situation might be in "real life."
- Example: If a mission is to "enter the house," the window is just as valid an entry point as the door.
- If a detail isn't mentioned, then it doesn't matter.
- Example: If a mission is to "put the cup on the table," upside down is just as valid as right side up.
- There are no hidden requirements or restrictions, but there are hidden freedoms, and you're encouraged to find them!

6 - EQUIPMENT

- Your equipment (robot, attachments, and other accessories) must be made entirely of LEGO elements in original factory condition.
  - Exception 1: You may reference a paper list to keep track of robot programs.
  - Exception 2: LEGO string and tubing may be cut to length.
- There are no restrictions on the quantities or sources of non-electric LEGO elements, except that factory-made wind-up/pull-back "motors" are not allowed. Pneumatic elements are allowed.
- Electric elements must be the LEGO MINDSTORMS type.
- The total number of each electric element you may use in any one match is limited as listed below.

To understand how these quantity limits are applied, let's consider for example, the motors:

- Imagine that a referee (a "ref") stops your entire team on your way to a match, and counts every motor every team member has - every motor on the robot, and on all separate attachments, and from every cart, and box, and from all your pockets… The total must not exceed three.
- If you have multiple motorized attachments, but it takes two motors to drive the robot, you must find a way to switch that third/last legal motor from one attachment to the next.
- A fourth motor is always illegal, no matter what.
- Even if you only plan to run three motors at a time, the fourth motor is illegal.
- Even if the fourth motor is a spare, or used as weight, or as decoration, the fourth motor is illegal.

For RCX Users:	For NXT Users:
Motors (3)	Motors (3)
RCX Controller (1)	NXT Controller (1)
Touch Sensors (2)	Touch Sensors (2)
Light Sensors (2)	Light Sensors (2)
Rotation Sensors (3)	Rotation Sensors (3 minus the number of NXT motors present)
3rd Touch OR Light Sensor (1)	Ultrasonic Sensor (1)
Lamp (1)	Lamp (1)

- Due to the above limits, you may not use more than one robot in any one match, but it's okay to use a different robot in a different match, earlier or later in the day.
- LEGO wires and converter cables are allowed as needed.
- Spare electrical parts are allowed in the PIT area.
- Computers are not allowed in the competition area.
- Objects functioning as remote controls are not allowed anywhere, at any time.
- Marker may be used for ownership identification, for marks in hidden areas only.
- Paint, tape, glue, oil, etc. are not allowed.
- Stickers are not allowed, except LEGO stickers, applied per LEGO instructions.
- If the robot is in violation - of this rule or Rule 7 - and cannot be corrected, the decision about exactly what to do rests with the tournament officials, but that robot may not win awards.

7 - SOFTWARE

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

8 - MISSION - A mission is a result or action worth points.

- The more missions the robot does, and the more valuable each one is, the higher your score.
- You decide the order you want to try missions in, and how many to try in each robot program.
- You may re-try missions when that's possible, but the field is not reset for that purpose.
- Most teams do anywhere between "some" and "most" of the missions. Very rare teams do them all.

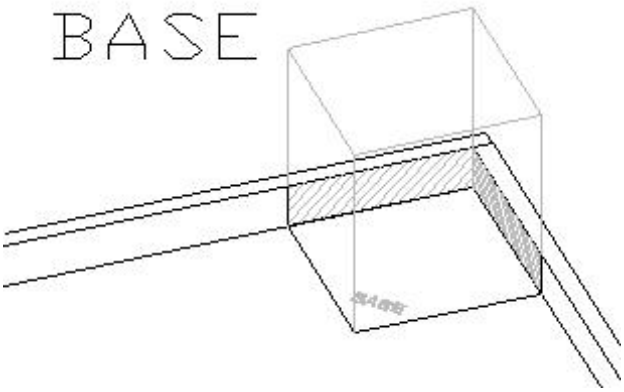
9 - MATCH - At a tournament, two robot game fields are joined back to back, and you are paired opposite another team to compete in a match. Each match lasts 2-1/2 minutes. Here's the process:

- You get to the competition table and have at least one minute to prepare your equipment. See Rule 17.
- The match starts and you start the robot. Once started, the robot is now "active" and is understood to be working on missions, under its own power and programming. See Rules 20, 21, and 16.
- The robot might get a lot done, or a little, but eventually you are likely to need/want to handle it. For example, it might get stuck, or you might want to add an attachment, or unload some cargo.
- If you do decide to touch the robot while it's active, no matter where it, is or what it's doing, that makes it

"inactive," and it must immediately be carried with its cargo to Base if it's not already there. See Rules 16, 17, and 22.
- While the inactive robot is in Base, you prepare it for its next active period, and restart it. See Rule 17.
- These steps repeat (often with music, an announcer, and cheering in the background!), until the match end signal sounds. The timer never pauses during a match.
- You play at least three matches a tournament, each one a fresh chance for you to get your best score.
- No match has anything to do with another, and only your best score counts specifically toward the Robot Performance Award. Exceptions: playoff matches and tie-breakers. See Rule 29.
- If it is known in advance that you will not have another team opposite you, a volunteer or "house" team will substitute. If not, and you compete against an empty table, you get the points for any missions that would have involved the missing team.

10 - ROUND - The process of cycling all teams through one match each is called a round.
- Tournaments run at least three rounds.
- Between your match in one round and the next, you usually have time to go to the pit area and work on the robot and its programs as needed, but this time might be limited, depending on the schedule of other proceedings, such as judging.

11 - BASE - Base is an imaginary box formed by vertical walls that rise from the perimeter of the Base area, including the inside surface of the border walls, and by an invisible ceiling 16 in (40 cm) high.
- This means Base is not just an area on the mat – it's a VOLUME.
- Usually there is a gap between the mat and a side border wall… Base includes this gap.



12 - FIELD - The field is where the robot game takes place. It consists of a field mat, on a table, with mission models arranged on top.
- The field mat and the LEGO elements for building the mission models are part of your Field Setup Kit.
- The instructions for building the mission models are on a CD which comes in the same box as the LEGO elements and mat.
- Other critical field setup instructions are on the Field Setup page – read them, please.

13 - MISSION MODELS - Mission models are the objects that are already on the field when you walk up to it.
- You may not bring duplicate mission models to the table if they could confuse scoring.
- You may not take mission models apart, even temporarily.
- You are limited as to how you may connect anything to a mission model. Gently flipping and/or shaking one (the heavier if the two are different) must allow gravity to completely separate them. The ref does not allow a start with an illegal connection. See Rule 20.
- Don't walk away with mission models from the competition area. Bring them back if you do. Thanks.

14 - CARGO - Cargo is anything the robot has with it for transport.

15 - AUTONOMY - The robot game is played by an "autonomous" robot.

- That means the robot must do its work without any influence/help from you while it's working. You PREPARE the robot, but it PERFORMS on its own.
- The robot may PERFORM ANYWHERE, but it may only be PREPARED in BASE.
- Any time you touch it, it is assumed to need your help and preparation in Base. See Rule 16.
- If this was planned, and the robot and its cargo are already in Base, no problem.
- But touching the robot outside Base is seen as a rescue, so there can be penalties. See Rule 22.

16 - ACTIVE ROBOT < > INACTIVE ROBOT

- At the moment the robot is started, it becomes "ACTIVE" (understood to be autonomous), and remains so until the next time you touch it.
- At the moment of that touch, the robot becomes "INACTIVE" (understood to need help), and must be carried to Base unless it's already there. See Rule 22.
- The inactive robot in Base may then be handled/prepared and restarted, so it's active again, etc. See Rule 17.

17 - HANDLING ALLOWED

- Before the match, and whenever else the robot is inactive, you may handle and prepare it by hand in Base for its next active period.
  - Typical robot handling and preparation includes repairs, switching attachments, selecting programs, resetting features, loading/unloading cargo, and aiming.
  - This work must take place in Base, but if some space right outside Base is needed, that's okay, just be sure not to disturb the field in any way.
- Objects in Base are yours to store, prepare, or stage for future interaction with the active robot. Just be sure they're stationary and you let go of them before the robot touches them.
- The only things you may do by hand OUTSIDE Base are:
  - Stop and lift the robot, any time. Consequences: See Rule 16.
  - Recover debris from accidental robot damage any time, as needed. See Rule 22.
  - Calibrate light sensors (before the match start only). See Rule 9.

18 - HANDLING NOT ALLOWED

- You may not cause things to extend, leave, or be placed outside Base, even partially, even temporarily, except as described in Rules 19 and 21.
- You may not move or adjust anything outside Base, before, during, or after the match.
- You may not request a field setup outside the range of specified setups, but you may ask the ref to double-check that a particular setup is correct/within spec.
- In the case of non-robot accidents: If your elbow, hip, clothing, or even the ref messes something up, this gets "undone" as fast and accurately as possible, if possible. Changes to the field caused or allowed by the removal of your inactive robot from the field are treated the same way.
- Objects staying on the field after any touch should be lowered to rest as close as possible to the place and orientation they were at the time of the touch.

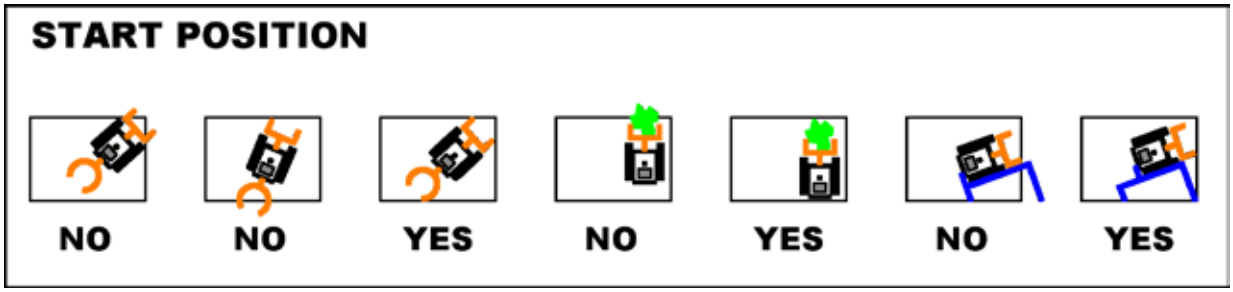
19 - STORAGE

- Once the ref inspects your equipment, you may store things as needed in Base, or in a box, either held by one of the two people at the table, or possibly on a stand, if stands are allowed at your event (decided by your tournament's officials – check with them in advance).
- In rare situations of objects crowding in Base, the ref allows you to store them on the field away from Base, but only if it is obvious their placement is purely for storage.
- Team members other than the two at the table may not hold equipment.
- Mission models and objects worth points in Base always need to stay in view of the ref.
- Nothing is allowed on the floor.

- At any time, objects in Base may be handled or stored, or even staged (completely in Base) for the robot to interact with later. Just be sure that your action has no real-time influence on the robot (that would be treated as if you touch it). See Rule 22.

20 - START POSITION

- For the match start and all restarts, EVERY BIT of the robot, including its installed attachments, everything touching it, and any objects it is about to move or use, must ALL fit COMPLETELY in Base.
- The ROBOT MAY be touching objects it is about to move or use.
- YOU may NOT be touching objects the robot is about to move or use.
- YOU may NOT be touching objects the robot is touching.
- Everything must be motionless.
- There must not be any illegal connections. See Rule 13.



21 - START PROCEDURE

- When it's obvious to the ref that starting position is correct…
  - For the first start of the match…
    - The ref asks you if you're ready, then signals your readiness to the announcer.
      - As the countdown starts, you reach in with one hand, ready to either touch a button, or signal a sensor, to start or resume the robot's program.
      - When you hear the sound, you start the robot. The exact time to start is at the beginning of the last word in the countdown, such as "Ready, set, GO!"
      - If a non-word signal is used, like a beep or buzzer, the start is at the beginning of that signal.
    - For all other starts in the same match (restarts)…
      - No countdown. The ref sees that start position is correct, and you start the robot.
- You may not handle the robot, or anything it's about to move or use, during or after the countdown, except for the single action needed to get the program running. If you do, the ref has you restart.

22 - TOUCH PENALTIES

If you touch the active robot or anything it's touching while:

- the ROBOT is outside Base, you lose one "touch penalty object" (identified in the Missions), if any are available at the time.
- a piece of CARGO is outside Base, you lose that piece of cargo, unless it was with the robot the last time the robot left Base.

If the only part of the robot crossing into Base at the time of the touch is a cord, hose, wire, tube, chain, string, or other feature obviously used purely for extension, the robot is treated as if it were outside Base.

When you touch the active robot, be sure to stop it immediately. If the INACTIVE robot makes a change to the field, the ref tries to undo it. If the change can't be undone,

- negative results stay "as is."
- missions benefitting are marked incomplete.

23 - ROBOT ACTIONS STAND - Anything done to your field by the active ROBOT outside Base STAYS that way, unless the active ROBOT changes it.

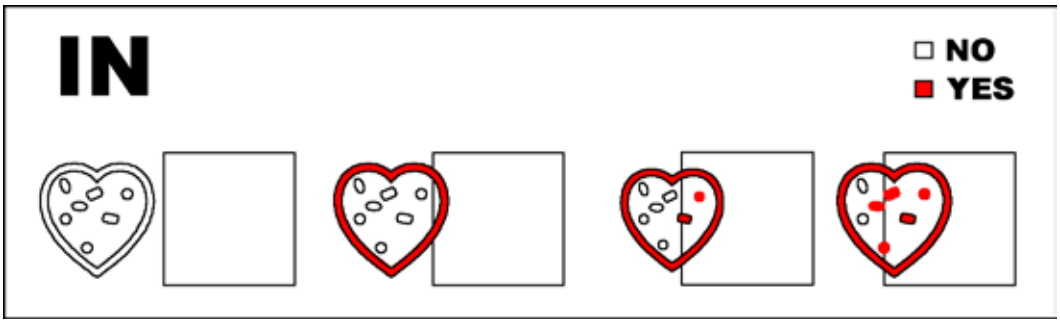
- Objects outside Base are not repaired, reset, recovered, or moved out of the way by hand.
- This means the robot can ruin its own opportunity to accomplish tasks, and it can even spoil previous progress/results
- If your active robot (untouched by you) loses contact with cargo, the cargo stays where it comes to rest unless/until the active robot regains contact with it. It may not be recovered by hand. Anything that comes off the table is kept by the ref.
  Exception: Parts not designed to separate from the robot, but which separate due to obviously accidental DAMAGE may be recovered by YOU, by hand, at any time – even if they have cargo (gift: you keep any cargo in question).

24 - INTERFERENCE - Your robot may not have any effect on the other team's robot, field, or strategy.

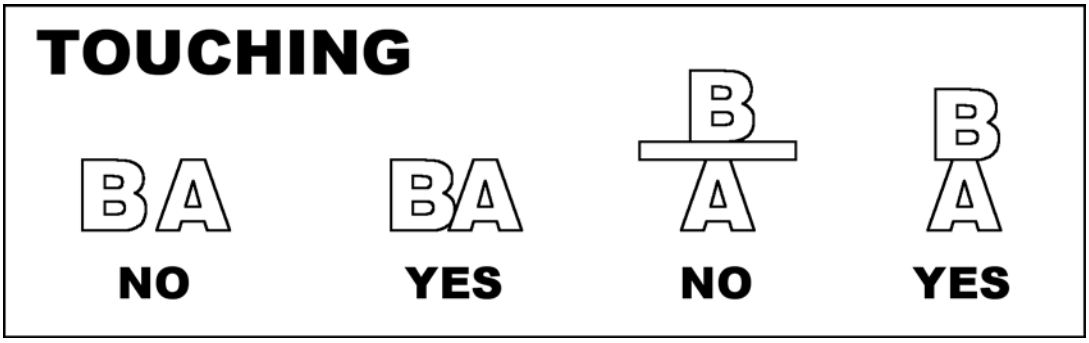
- Near the model(s) shared between both teams…
  - Exception: If your robot is simply trying to complete missions there, interference is expected and acceptable.
  - If Robot X deliberately blocks or un-scores Robot Y's progress/results, Robot X's mission(s) in that area are marked as incomplete, and Robot Y's are marked as complete.
  - As a matter of luck, the other team might be able to out-perform you in the shared area, or might fail to cooperate with you there. This is not considered interference.

25 - IN - A is "in," "into," or has "reached" area B if ANY BIT of A is OVER area B.

- To be "in" an area is to penetrate the volume over that area. Base is a special case; see Rule 11.
- Barely "in" is considered "in" unless the phrase "completely in" is used.
- Touching (direct contact) isn't needed/doesn't matter when assessing if something is "in."
- Objects are ruled on independent of each other, and independent of their transports/containers.



26 - TOUCHING (for objects other than the robot) - A is "touching" B only if A is making direct contact with B. Any amount of direct contact counts as touching. Exception: See Rule 19, last bullet.



27 - FINAL FIELD CONDITION SCORING - To minimize controversy about what happened during a match, the overall score is determined at the END of the match, by the SNAPSHOT condition of the field at that EXACT time only.

- This means that points are not given for results the robot produces early in the match but then trashes before the match ends.
- Rarely, a method is required as well as a result. In that case, the ref notes whether the required method is used.

28 - AFTER THE MATCH - No one is allowed to touch anything on the field yet…

- The ref first needs time to record the condition of the field, and come to agreement with you (kids only) about what points were scored or missed and why (and to be sure you're not walking away with any of that field's mission models!). Data is marked on a sheet which you initial, making the sheet final.
- The scores are tallied by computer, with ties being broken using 2nd, then 3rd highest scores. If more than one team gets a perfect score in all regular rounds, tournament officials decide what to do, among options such as holding "first-to-perfect" playoffs, or awarding multiple Performance Awards.

29 - BENEFIT OF THE DOUBT

You get the benefit of the doubt when:

- a split-second or the thickness of a (thin) line is a factor.
- a situation could "go either way" due to confusing, conflicting, or missing information.
- a ref is tempted to rule based on the "intent" of a requirement or constraint.
- no one's really sure WHAT just happened!

If you (kids, not coach) disagree with the ref and can respectfully raise sufficient doubt in his/her mind during your post-match chat, the ref meets with the head ref, and the resultant decision is final. This rule is not an order for the refs to be lenient, but it is a license for them to make judgment calls in your favor when it's reasonable to do so.

30 - DOWNLOADING AND WIRELESS SIGNALS

- Downloading programs to robots may take place in the pits only - never in the competition area.
- If downloading to an RCX controller, make sure the process is shielded, and that there are no other RCX robots in range. RCX robots must be turned off when not in use.
- If downloading to an NXT controller, do so by cable. Bluetooth must be switched off at all times.

31 - VARIABILITY - As you build and program, keep in mind that our suppliers, donors, and volunteers make every effort to ensure that all fields are correct and identical, but you should always expect some variability, such as:

- flaws in the border walls.
- variety in lighting conditions, from hour to hour, and/or table to table..
- texture/bumps under the mat.
- Presence or absence of tape at the East and West edges of the mat.
- waviness in the mat itself - at many tournaments, it is impossible for the mats to be rolled out in time to lose their waviness. Location and severity of waviness varies. You are being warned here. Consider this while designing.
- Two important building techniques you can use to limit the effects of variability are:
  - Avoid steering systems that involve something sliding on the mat or border walls.
  - Cover your light sensors from surrounding light.
- Questions about conditions at a particular tournament should only be directed to tournament officials.

32 - PRECEDENCE/AUTHORITY

- You get information about the robot game from more than one place. Once in a while, information from different places conflicts. So here is the order of precedence for the sources:
  1 = CURRENT Robot Game Rulings page
  2 = Missions and Field Setup pages
  3 = Rules page
- If something on a page conflicts with something else on the same page, the most sensible interpretation is assumed. If they seem equal, the interpretation most favorable for the team is assumed.

- On all pages, videos and pictures are for guidance and example only. Often they can not express complete information, and are therefore misleading… When there is conflict between pictures/videos and text, the text takes precedence!
- The head ref at a tournament is required to base decisions on the information above, in the order shown above. No other source of information is official, including e-mails from Robot Game Support.

33 - ROBOT GAME SUPPORT - Professional/expert robot game support is available directly from the designer/author (Scott) at fllrobotgame@usfirst.org (usual response in 1-2 business days).

- When e-mailing, please state your role in FLL (member, coach, parent, mentor, referee).
- You'll get a reply with personalized guidance constructing requirement/restriction-based paths of logic/reason for assessing special strategies or situations in terms of legality and scoring.
- The ref is not obligated to read response e-mails, but your case might prompt a posting on the Robot Game Rulings page if it's popular, reveals missing or confusing text, reveals a flaw in the game, reveals an unresolvable conflict, or is amazing or entertaining.
- No new Robot Game Ruling entries are posted after 3PM (eastern U.S.) on Fridays.
- You won't get help/advice about building or programming (that's your challenge).
- Questions about LEGO product in general get redirected: Instead call 1-866-349-LEGO.
- Questions posted in the discussion forum are not seen nor responded to by Robot Game Support.

WARNING: The forum is great for sharing ideas and getting tips from other teams, but it is not an official source of answers about anything.

34 - COACHES' MEETING

- If a question does come up right before the tournament, your last chance to ask it is at the "Coaches' Meeting" (if there is one) the morning of the tournament.
- The head ref and coaches meet to identify and settle any differences BEFORE the first match.
- For the rest of the day, the ref's calls are final when you leave the table.

Summary Of Significant Content Changes For 2010 (bold underlined denotes serious changes)

A - No longer need definitions for the robot, attachments, or strategic objects – "Cargo" introduced, Rule 14.
B - Light sensor calibration specifically allowed, Rule 17.
C - Housekeeping and Muscle Action rules rolled into Rules 17, 18, and 19.
D - Loss Of Contact rolled into Rule 23.
E - Referees no longer expected to fix active robot field damage, Rule 23.
F - Stray Objects rule removed, Rule 23.
G - Leniency promoting objects to be taken into Base when the robot reaches Base is removed, Rule 22.
H - Tether rule strengthened to include solid extensions and remove loopholes, Rule 22.

FIRST® LEGO® League

BODY FORWARD

2010 FLL CHALLENGE

ROBOT GAME – MISSIONS

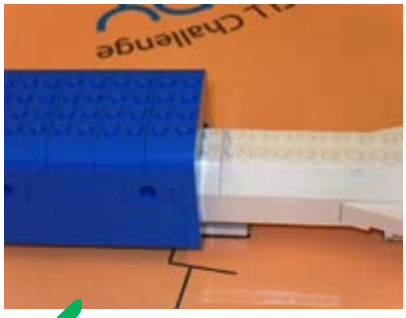
Biomedical engineering is the use of various engineering disciplines to help doctors and hospitals help patients. The fields of chemical, mechanical, electrical, and other forms of engineering are mixed with traditional biological and medical sciences to advance healthcare.

COMMON BONE REPAIR

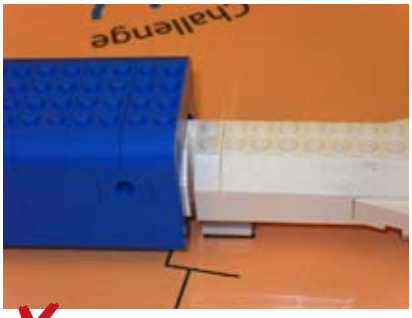
The "cast"… This material softly conforms to you, then hardens like a rock. When it comes off, the process doesn't crush, cut, burn, or dissolve your body! What types of engineering do you think are involved?

MISSION - Set (align) the arm bone, then apply the blue cast. The cast needs to be all the way down, and it needs to completely cover the break.

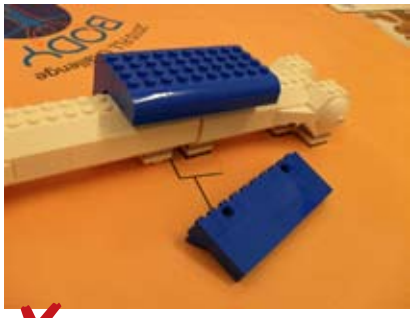
CAST APPLIED = **25** Points



✔ SCORE



✗ NO SCORE



✗ NO SCORE

SPECIAL BONE REPAIR

Some severe fractures, including some cases where bone is missing, can't be fixed with a cast. But now, biomedical engineers are developing a way to bridge voids of missing bone by introducing special bone growing cells to the area on a material called "scaffolding." These cells are able to grow new bone in ways our normal healing processes can't.

MISSION - Insert the bone bridge in the leg. Then test the repair by moving the leg so the foot kicks the ball, hopefully scoring a goal.

BONE BRIDGE INSERTED = **15** Points
---There are two ways to get bone bridge points:
1 - The referee can inspect the insertion at the end of the match and see that the bone bridge is inserted all the way down.
---OR---
2 - The referee automatically scores the bone bridge if a goal is scored.

GOAL SCORED = **25** Points

---Only the leg and bone bridge can move the foot (the robot must pivot the leg only).

---Only the foot can move/propel the ball.

---The bone bridge must not touch the mat.

---The ball must be touching the green area in the goal when the match ends.

✔ BONE BRIDGE SCORE

✔ GOAL + BONE BRIDGE SCORE

RAPID BLOOD SCREENING

Since white blood cells are the army that helps a body fight infection, doctors are always interested in taking them from blood samples. But only about 1 in 700 blood cells is a white, and faster and faster methods are always needed for screening out the whites.

MISSION - Get the syringe to Base. Then separate the white blood cells from the red ones (this part can be done by hand). Finally, get ONLY the whites blood cells into the patient's area (anywhere in the non-orange region at the east of the mat). The syringe and any blood cells in it may be handled/ separated by hand as soon as any part of the syringe reaches Base.

SYRINGE IN BASE = **25** Points

ALL THREE WHITE BLOOD CELLS IN PATIENT'S AREA = **15** Points

✔ SCORE

✗ NO SCORE

✗ NO SCORE

✗ NO SCORE

TOUCH PENALTY OBJECTS - Red blood cells are this game's "touch penalty objects" as described in the Rules. They're each worth automatic/free points anywhere on the field. But touching the active robot outside Base causes the referee to take one red blood cell from the field, each time, until they're gone.

RED BLOOD CELLS NOT TAKEN BY THE REFEREE = **5** Points each

BAD CELL DESTRUCTION

Deadly disease can result from cells themselves turning bad yet continuing to reproduce. Unfortunately, most of the methods for eliminating those bad cells don't work very well, and they hurt lots of other cells in your body, causing new severe problems. The solution to this problem will be a historic breakthrough and it will likely require a biomedical engineering approach.

MISSION – Some bad cells (black panels) are set randomly to face South, and the rest to face North. This randomization happens whenever the robot is outside Base, unless the robot is currently interacting with the cells, or has already gotten them into scoring position…

---Show bad-cell identification by clicking cells such that some blacks face up, and the rest face North.

IDENTIFICATION = **20** Points

---OR---

---Show bad-cell destruction by clicking cells such that 5 blacks face North.

DESTRUCTION = **25** Points

Positions must be fully clicked in either case.

RANDOM SETUP

✔ IDENTIFICATION SCORE

✔ DESTRUCTION SCORE

MECHANICAL ARM PATENT

Your hand can reach into your pocket, pull out a set of keys, identify the right one, put it into the lock, and unlock a door, all in the dark. No other mechanism in the world can do that. But for people who have lost limbs, biomedical engineers are developing better and better artificial ones all the time. Who will be the first to think of the next new idea?

MISSION - Get the mechanical hand to hold the patent. If two hands are holding the patent, both teams get full points.

PATENT IS GRABBED BY YOUR SIDE'S HAND = **25** Points

CARDIAC PATCH

Having a hole in your heart is considered a rare condition by some, but if you're one of the few hundred thousand people with this condition, you're glad that biomedical engineers are hard at work developing modern solutions for it. One solution is to place special cardiac cells onto a mesh to form new heart tissue which can seal the hole. Presently this patch doesn't grow as a child's heart grows, so repeat operations are needed… There's a challenge for tomorrow's biomedical engineer!

MISSION - Get the cardiac patch into the heart.

PATCH APPLIED = **20** Points

✔ SCORE

✔ SCORE

✔ SCORE

READ OTHER IMPORTANT PAGES TOO

You are currently reading the "Missions" document, which is only about half of what you need to know in order to do your best at a tournament. There are three other documents your team needs to become experts on: The Field Setup, the Rules, and the posted/updated Rulings. Invest a meeting to go over them, even if you're a veteran team. Ask about anything that's not clear.

MISSION: Read all four robot game docs, and go over them often. They'll mean more to you each time.

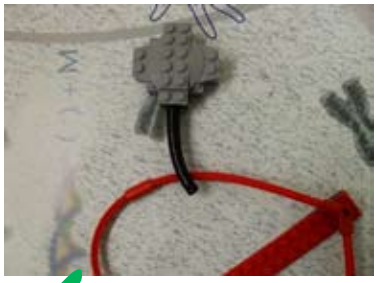
DOCUMENT EXPERTS ON YOUR TEAM = **CRITICAL**

PACE MAKER

One of the earliest examples of modern biomedical engineering - Can you list all the different engineering and medical disciplines required in the manufacture and installation of a pace maker?

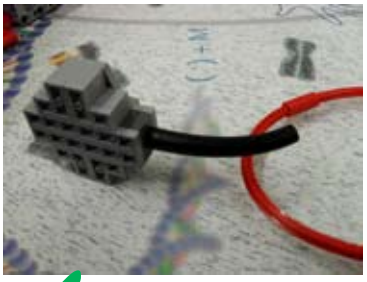
MISSION - Install the pace maker in the heart so that the free end of the black tube is in the heart, but the gray body of the pace maker is not.

PACE MAKER TUBE END IN HEART, BODY OUT = **25** Points



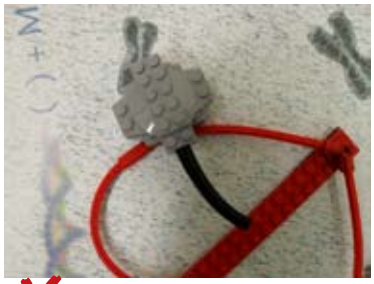
✔ SCORE

✔ SCORE



✔ SCORE

✘ NO SCORE



✘ NO SCORE

NERVE MAPPING

When you see a person using an electromechanical prosthetic hand, have you ever wondered how the person's brain tells that device what to do? At some point, nerves from the brain have to signal the new hand's wires, but how does the surgeon know what nerves and what wires to connect? When you think "move small finger outward," exactly what area of what nerve gets that signal?

MISSION - Move the brain's West input nerve to see which nerve shows an East output signal. The red of one of the output nerves needs to be obviously moved outward from the brain, but it doesn't matter how far.

NERVE INPUT / OUTPUT REVEALED = **15** Points

OBJECT CONTROL THROUGH THOUGHT

We know that nerve mapping and physical therapy (practice) can enable a person's brain to activate a prosthetic hand, so would it be possible for a person's brain to activate a remote control, which could operate other devices around the living space a person with a disability?

MISSION – Open the door at least half way by only moving the brain's South input nerve.

DOOR OPEN AT LEAST HALF WAY = **20** Points

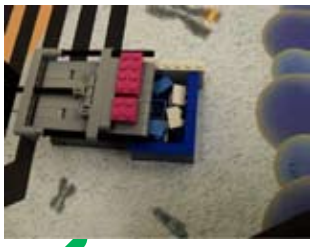
MEDICINE AUTO-DISPENSING

If you're unorganized, forgetful, or have no one helping you, you probably forget to take your vitamins sometimes, and that's okay. But what if you had many different medicines to take, all at different times, in different doses? And what if missing them or taking the wrong amount could cause serious problems? For many people, this means they can't live on their own any more, and have to go live where nurses can take care of them. Can you think of a device that would solve this problem?

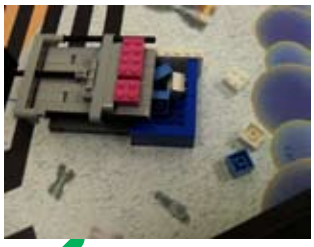
MISSION – Dispense all of the blue and white, but no pink medicine from the dispenser. Also, get the container with blue and white medicine (at least one of each) into the patient's area.

BLUE AND WHITES OFF, PINKS ON = **25** Points

BLUE AND WHITE IN CONTAINER IN PATIENT'S AREA = **5** Points

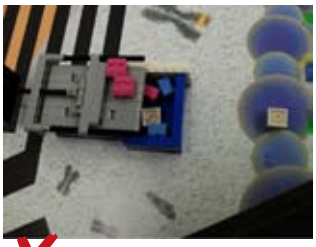


✔ SCORE PART 1
(PART 2 STILL POSSIBLE)

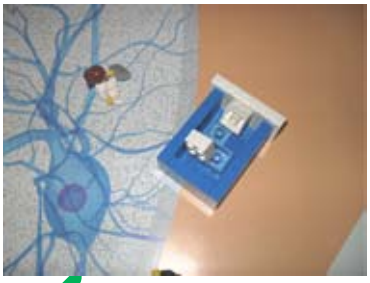


✔ SCORE PART 1
(PART 2 STILL POSSIBLE)

✔ SCORE PART 1
(PART 2 STILL POSSIBLE)



✘ NO SCORE
(PART 2 STILL POSSIBLE)



✔ PART 2 SCORE

ROBOTIC SENSITIVITY

It takes a lot of sophistication and therapy for an artificial hand and its user to find the correct angles for the many pivots and extensions of movement, but what about the forces? It takes a lot less force to grip a sandwich than a rock… What about handling eggs – or kittens? How is the correct force found?

MISSION - Get the weight to the up position by pushing the blue panel only.

WEIGHT ALL THE WAY UP = **25** Points

PROFESSIONAL TEAMWORK

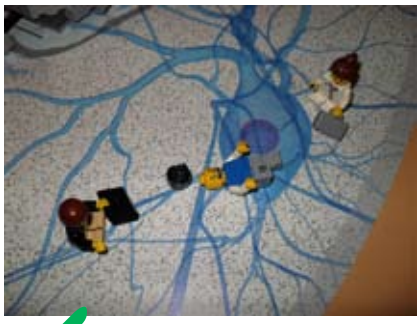
Biomedical engineering applications need to be exactly right, sometimes for a wide variety of patients, and sometimes for a particular patient. In either case, it's extremely important for biomedical engineers to maintain very good communication with doctors as well as patients as solutions are developed.

MISSION - Move both the doctor and the biomedical engineer to meet with the patient, anywhere in the patient's area.

PEOPLE ALL TOGETHER IN THE PATIENT'S AREA = **25** Points

✗ NO SCORE

✗ NO SCORE



✓ SCORE

✓ SCORE

✗ SORRY, NO SCORE

✓ SCORE

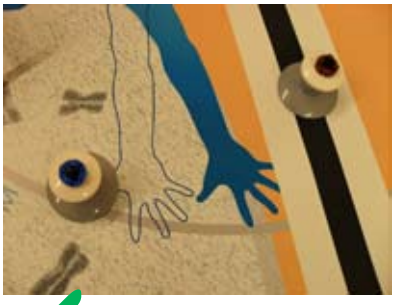
BIONIC EYES

Visual prosthetics in their current stage of development allow perception of light and patterns, holding promise to increase a blind person's mobility and independence. How far will they go to help people in the future?

MISSION - Move at least one bionic eye so it's touching the upper body (solid or outline) of the person at the center of the field.

AT LEAST ONE EYE TOUCHING UPPER BODY = **20** Points

✔ SCORE



✔ SCORE

✔ SCORE

✗ NO SCORE

✗ NO SCORE

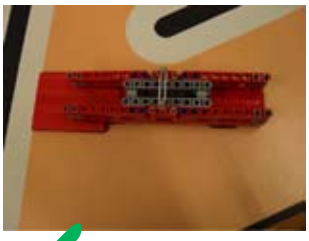
✗ NO SCORE

STENT

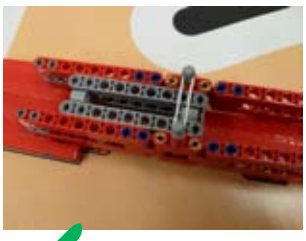
There are several reasons why a vessel carrying fluid through your body can become constricted, and none of them are good! Luckily biomedical engineers invented stents. A stent is a small section of tube that can be inserted into a constricted vessel to widen and reinforce it. This simple, brilliant idea has saved many, many lives.

MISSION - Widen the constricted artery by inserting the stent. Opposing artery walls must be obviously parallel to each other.

STENT INSTALLED / ARTERY EXPANDED = **25** Points



✔ SCORE



✔ SCORE

✔ SCORE

✗ NO SCORE