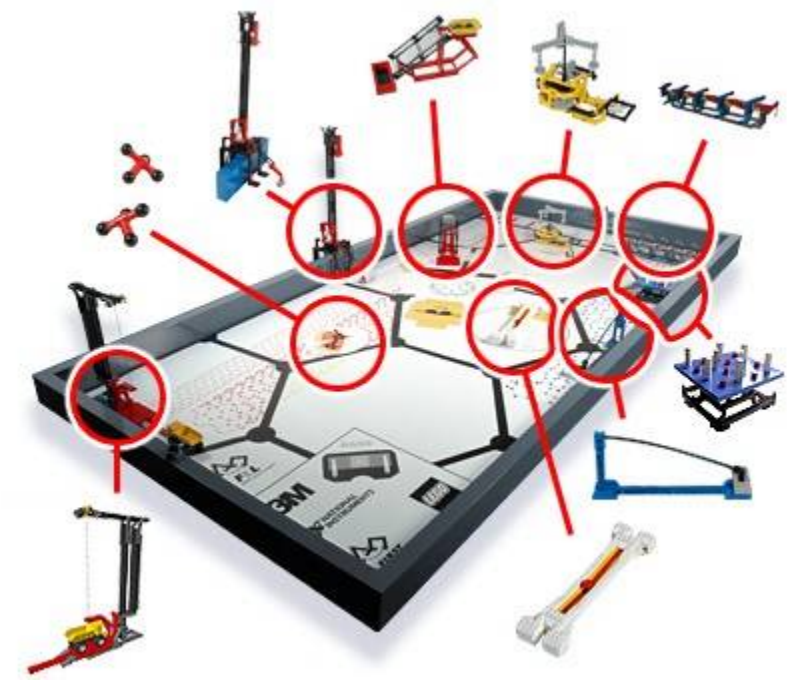
2006 Nanoquest Challenge

Missions, Rules, Field Set Up, Project

Missions



- **Individual Atom Manipulation**

Mission: Move individual atoms accurately. The robot must remove at least 1 white atom from the blue surface without removing any red atoms. Counting atoms left on the surface, a count of fewer than 8 red atoms is worth no points. A count of 8 red atoms and 7 or 6 white atoms is worth 30 points. A count of 8 red atoms and 5 or fewer white atoms is worth 40 points.

Background: Lots of structures and processes involve materials loosely combined, like a pile of bricks, or material moving unpredictably, like thundershowers. But when we apply science, engineering, and work on the "macro" scale, we can turn bricks into cities and pipe water into our homes. Materials can be made or moved atom by atom, allowing special new properties and uses. Nanotechnology is about applying science, engineering, and work on the "nano" scale, where measurements range up to about 100 nanometers—the size of a few molecules—and where everything is moving and shaking.

Smell

Mission: Transfer molecules from the pizza toward the nose. The robot must get pizza molecules completely off the paper plate for 5 points each, and transferred to the yellow or black areas of the person's head or neck for an additional 10 points each.

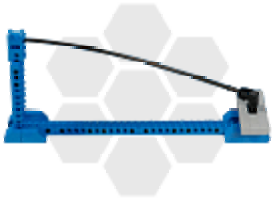
Background: Do you realize that when you smell something yummy or disgusting, it means that molecules from that substance have reached your nose? You can't even see them, but they're there. Imagine trying to work with these nano scale objects to invent things and solve problems…that's nanotechnology!

Stain-Resistant Fabric

Mission: Test some stain-resistant fabric. The robot must deliver the dirt trap to its location mark and completely dump out the tester's dirt dumper. The dirt trap at its mark is worth 15 points, and the dirt dumper when empty is worth 15 points. The dirt pieces are Bonus Objects, worth 5 points each in the dirt trap, and 3 points each everywhere else on the table. When removing dirt for a Bonus Loss, the referee takes stray pieces first, then pieces from the dumper, and pieces from the trap last.

Background: Nanotechnology can be thought of as the understanding and use of traditional sciences on the nano scale to achieve results we've never seen before, and those results are already finding their way into our daily lives. For example, a special treatment for fabric is already becoming available that can make it impossible to get your clothes wet or dirty!

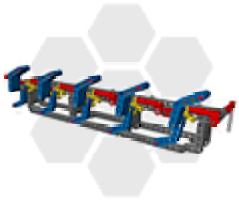
Atomic Force Microscopy



Mission: Free the probe's nanotip. The robot must separate the nanotip from the material surface. The nanotip separated from the surface is worth 40 points.

Background: In the same way you can describe a surface as bumpy, sticky, or hot through the use of your finger on the large "macro" scale, the atomic force microscope can describe a surface atom by atom through the use of its probe on the nano scale. Unfortunately, the probe's nanotip often gets stuck on the surface, frustrating scientists.

Self-Assembly



Mission: Start the self-alignment of atoms. The robot must cause the angled blue nanotube segments to align horizontally end to end. This alignment is worth 30 points.

Background: Atoms are super-super small, so it's very difficult and time consuming to work with them 1 by 1. For example, moving 3 atoms at a time (each water molecule has 2 hydrogen atoms and 1 oxygen atom), it would take about one hundred and seventy thousand million trillion loads to fill 1 teaspoon with water! With this in mind, an important part of nanotechnology is to find ways to get atoms and molecules to arrange themselves, sort of like magnets do.

Smart Medicine

Mission: Target medicine to reach only a specific problem spot. The robot must release the Buckyball containing medicine into the person's arm. The Buckyball is placed anywhere in the red/yellow channel of the arm bone is worth 50 points (even if it hasn't reached the problem spot).

Background: When we are given medicine, it usually circulates throughout the body, and often causes harmful side effects in unintended areas. But through nanotechnology, some medicines can be strategically placed inside special molecules like the C60 Buckyball molecules, that only allow delivery to the exact area where the medicine is needed.

Nanotube Strength

Mission: Lift the truck by a thin cable of carbon nanotubes. The robot must move the truck onto the lift frame and activate the lift. The truck completely on the frame is worth 20 points. The truck and frame supported completely and only by the cable is worth an additional 20 points.

Background: The carbon atom is of special interest in nanotechnology. One of the reasons for this is that carbon atoms can be arranged to form carbon nanotubes, which can form the basis of some unbelievably strong materials. Imagine a cable as thin as a toothpick, weighing one-sixth as much as a steel cable of the same size, yet it could support the weight of a car!

- ## Molecular Motor

Mission: Deliver an adenosine triphosphate (ATP) molecule to power a molecular motor, causing it to spin and release energy. The robot must deliver 1 of the 2 ATP molecules through the molecular motor's black frame for 40 points (even if nothing else happens). The second ATP molecule represents a second chance to complete this mission, but points are only given for 1 delivered molecule.

Background: Atoms and molecules are always moving or shaking, like loose balloons in a room full of fans. This can make it hard to work with them, but the right molecule spinning a certain way can actually be used to do work. Molecular motors are molecules that can convert chemical energy from other molecules into rotational energy, like a power tool, to do work on a scale where no other mechanical tool could fit—work such as transporting other molecules or contracting muscles.

- ## Space Elevator

Mission: Operate the space elevator. At least one robot must cause the car with the yellow cargo to come down. If this mission is completed, no matter which robot or robots worked on it, both teams get 40 points.

Background: Do you know why the moon and other satellites don't fall to earth or escape into space? It's for the same reason that you can swing an open bucket of water in a vertical circle and the water stays in the bucket. The water is swinging fast enough to be thrown up into the air, but that force is balanced by the strength of your arm holding the bucket. In the same way, satellites are moving just fast enough and at just the right height to balance gravity's force on them, so they stay at the same place in space, sometimes above a particular spot on earth. Now imagine running a cable from the ground all the way to a satellite in space. If there were a cable material light enough and strong enough, like carbon nanotubes, could this be done? Could we send cargo or even people into space on an elevator, instead of on rockets?

Fairness Bonus

For 20 bonus points, an RCX robot must earn points in any 3 missions, or an NXT robot must earn points in any 6 missions.

Rules

1. READ THIS FIRST To maximize performance and eliminate surprises, you must take the time to read and understand FOUR documents: the Field Setup Instructions, the Missions, the Rules, and the CURRENT Questions & Answers (Q&A) page on the web.

2. MATCH At a tournament, two Challenge fields are joined back to back, and each team is paired opposite another to compete in a match. For 2-1/2 minutes, the robot tries to get the most points it can by completing missions. The timer never pauses during a match. Each match is a fresh chance for the team to get its best score, and no match has anything to do with another.

3. MISSION A mission is a job the robot can complete for points. The robot starts from Base and goes out on one or more trips to try to complete one or more missions per trip. Missions may be tried in any order, alone or in groups, re-tried when possible and allowable, or skipped. Points are given if the required results are still visible on the field at the END of the match.

4. ROUND The process of cycling all teams through one match each is called a round. Most tournaments run at least 3 rounds, and teams have time between their matches to go to the pit area and work on the robot and its programs as needed.

5. PARTICIPATION The maximum allowable team size is 10 members, not including coaches and mentors. See the 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 may stay nearby, but away from the table. To share in participation, members may rotate in/out at any time.

6. AUTONOMY Robot performance must be autonomous (hands off, Bluetooth off). After preparation by the team, the robot is required to leave Base completely and accomplish missions BY ITSELF, and return (if needed) to Base BY ITSELF. Most robots require multiple trips, with some rescue and/or preparation between trips. If the team does rescue (touch/handle) the robot, depending on where the robot is and what it's doing, there could be negative consequences such as mandatory restarts, loss of control of objects, and reversal of changes to the field.

7. ROBOT The robot is defined as the RCX OR NXT brick and anything currently connected or attached to it. Mission models, strategic objects, separate pieces, and separate mechanisms are not part of the robot.

8. MATERIALS At the competition table, the robot, its attachments, and all strategic objects must be made entirely of LEGO elements in original factory condition (except LEGO string and tubing may be cut to length). At the competition table, the total package of robot, attachments, and strategic objects when viewed all at once must conform to the following quantity limits on electrical parts, no matter what the team intends to use at any one time:

For RCX users:
RCX controller (1)
motors (3)
touch sensors (2)
light sensors (2)
lamp (1)
rotation sensors (3)
3rd touch OR light sensors (1)

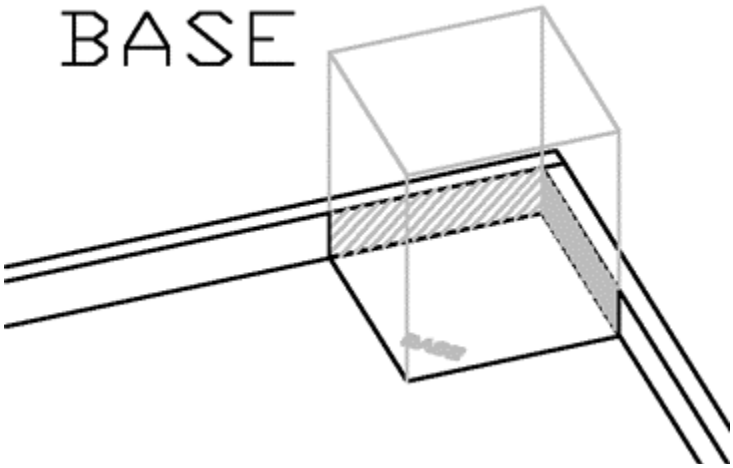
For NXT users:
NXT controller (1)
motors (3)
touch sensors (2)
light sensors (2)
lamp (1)
rotation sensors (3 minus the number of NXT motors present)
ultrasonic sensor (1)

LEGO wires and converter cables are allowed as needed. Spare/alternate electrical parts are allowed in the pit area. Objects functioning as remote controls are not allowed anywhere. There are no restrictions on the quantity or source of non-electric LEGO pieces. Stickers, paint, tape, glue, oil, etc. are not allowed, except marker may be used for owner identification in hidden areas only. To participate in a match, a team must follow this rule.

9. SOFTWARE The robot must be programmed using LEGO MindStorms or RoboLab software (any version).

10. DOWNLOADING One team's download can erase another team's programs and ruin their performance. Therefore, downloading is only allowed in the pit area, download settings must be kept on short range, the process must be shielded from surrounding teams, Bluetooth must be switched off, and the robot should be kept OFF when not in use.

11. BASE Base is an imaginary hollow shape formed by vertical walls that rise from the perimeter of the Base's footprint (including the inside surfaces of the border walls), and by an invisible ceiling 16 in (40 cm) high. NOTE: Base is a VOLUME—not an area.



12. OPERATIONAL DEFINITIONS Though the Challenge is fun, it is robotics after all, and like all technical work it depends on specifics and exact descriptions of physical conditions. So to limit language-induced confusion, the following operational definitions are provided for the location of objects (including the robot) with respect to the missions, rules, and Q&A:

To/At/Reach: When an object must get TO, be AT, or REACH a target, it is sufficient for any portion of the object to barely cross over the outer edge of the target.

On/Onto: When an object must be ON or get ONTO a target, the target should be able to support all the weight of the object when any/all other supports are removed, as proven or estimated by the referee (ref).

In/Into: When an object must be IN or get INTO a (container-type) target, the object must be trapped from being dislodged in at least 5 directions.

Touching: When and ONLY when an object must be TOUCHING a target, the object itself must be making direct contact with the target.

Completely: When an object must meet a condition COMPLETELY, every bit of the object must meet the condition.

13. STRATEGIC OBJECTS Strategic objects are allowed and defined as any team-designed/supplied objects other than the robot and its attachments, handled by the team during preparation only, or used by the robot with three constraints: 1) they must be used/released by the robot, 2) they must be completely out of Base when used/released, and 3) the robot must be completely out of Base when it uses/releases them. This rule includes strategic objects containing wind-up or pull-back "motors."

14. STRAY OBJECTS Any object caused by a robot to be in the way of either team's robot performance may be moved by the referee upon team request if that can be done without a direct effect on scoring. Objects in scoring position may be shifted to equivalent scoring positions if possible, and worthless objects may be removed from the table.

15. DELIVERABLES A deliverable object originates in Base, and could be worth points outside of Base. If the robot is touched while delivering a deliverable, that object is given to the team back in Base for another try. Each deliverable object must itself meet the mission requirements for points, whether or not it is packaged, or joined with other deliverables, and

no matter where the robot is.

16. RETRIEVABLES A retrievable object originates outside of Base, and is worth points at Base. If the robot is touched while retrieving a retrievable and before that object has reached Base, that object is simply released in whatever place and position it was in at the time of the touch, and may be considered stray. Each retrievable object must itself reach Base for points, no matter where the robot is, with leniency in close situations. As soon as a retrievable in contact with the robot reaches Base, both the robot and the object may be touched by the team without causing a Bonus Loss.

17. TRANSFERABLES A transferable object originates outside of Base, and could be worth points outside of Base. If the robot is touched while transferring a transferable, that object is simply released in whatever place and position it was in at the time of the touch, and may be considered stray. A transferable object must itself meet the mission requirements for points, whether or not it is packaged, or joined with other transferables, and no matter where the robot is.

18. PREPARATION Before the match and between trips into the field, the robot may be repaired, reconfigured with attachments, loaded/unloaded, and aimed. Its mechanisms may be set/reset, its buttons may be pressed, and its sensors may be signaled. This handling of the robot must take place at Base. Objects apart from the robot may be handled at Base or off the table at any time.

19. HOUSEKEEPING Any objects at Base which could get in the way of the robot's preparation or motion may be kept "near" Base as long as they do not cause any changes in the field.

20. STARTING POSITION For all starts, all portions of the robot (not just where it contacts the mat) and its currently used attachments, strategic objects, and deliverables must start from completely in Base, with leniency for slight overextensions.

21. STARTING TECHNIQUE To be allowed to start, the robot must be motionless and the team must not be touching it. The team is then allowed to use one of three ways to put the robot into motion: 1) touch a button, 2) signal a sensor, 3) wait for a running/paused program to resume. The team must not handle the robot in any other way throughout the start. Successfully started, the robot is then performing autonomously.

22. ROBOT MUST LEAVE BASE Directly after every start, the robot must leave Base completely before it is allowed to make contact with any objects outside of Base and before it loses contact with any deliverable or strategic object. The robot is not allowed to cause objects to cross out of Base unless they are being taken along in contact with it through pushing, carrying, or pulling.

23. RESTARTS Any time a performing robot is touched, no matter where the robot is, it is considered STOPPED and must immediately be returned to Base if it's not already there. The team may then make preparations, and follow the STARTING TECHNIQUE again

when ready. NOTE: The robot does not have to return to Base unless the team touches it, or unless a mission specifically requires it.

24. BONUS OBJECTS/LOSS Bonus objects are worth points anywhere on the table. Each time the robot is touched while completely out of Base, the ref removes one bonus object from the table if there are any available at that time. If the robot is touched while crossing into or out of Base, or while in contact with a retrievable which is crossing into base, there is no bonus loss.

25. REVERSALS There are three situations that could cause the ref to reverse (undo) changes in the field: 1) when a change happens through unallowable action, 2) when field damage occurs, and 3) when a result worth points is achieved through a method other than the one required.

26. MUSCLE ACTION The team is not allowed to cause anything but the robot to leave or extend out of Base except as described in the ROBOT MUST LEAVE BASE rule.

27. INTERFERENCE Your team's robot is not allowed to have any effect on the other team's robot, field, or strategy except by directly meeting the scoring requirements of missions in areas that are shared between the two sides by design of the Challenge.

28. LOSS OF CONTACT When the robot is completely out of Base and loses contact with a deliverable, retrievable, transferable, or strategic object, that object stays where it is and may be considered stray.

29. ROBOT DAMAGE At any time during the match, the team may recover robot parts that come off as result of obviously unintentional damage. The team may do this by hand or request help from the ref.

30. FIELD DAMAGE The team is not allowed to handle mission models outside of Base. The team must use the mission models supplied by the tournament and must not bring duplicates to the competition area. Changes in the field are never restored by hand for the sake of giving the team "more tries." However, if a mission model accidentally breaks, malfunctions, moves, or is activated by anything other than allowable robot action, the ref reverses the change as soon as possible (if possible), and gives the benefit of the doubt if points are in question. Intentional field damage is also reversed, but draws a warning, and could result in denial of points. Field damage too severe to reverse is left as is and could fall under the STRAY OBJECTS rule.

31. SCORE DETERMINATION To minimize controversy about what happened during a Match, THE SCORE IS DETERMINED AT THE END OF THE MATCH, BY THE CONDITION OF THE FIELD AT THAT TIME ONLY. This means that points are not given for accomplishments that the robot accidentally trashes before the match ends.

32. BENEFIT OF THE DOUBT In situations that are too close to call, like when a split-second or the thickness of a line is a factor, the team gets the benefit of the doubt. In general

where the team disagrees with the ref and the team can respectfully raise sufficient doubt in the ref's mind, the ref meets with the head ref, and the resultant decision is final. Here, the team should NOT necessarily expect the benefit of the doubt.

33. AFTER THE MATCH At the end of each match, the ref and the team look at the field together and come to agreement about what points were given or missed and why, and to be sure that the team is not walking away with any mission models.

34. VARIABILITY Every effort is made by our suppliers, donors, and volunteers to ensure that all fields are correct and identical, but some variability is to be expected, such as texture/bumps under the mat, flaws in the border walls, and variety in lighting conditions and rigging. Although the robot is allowed to extend over the tops of the border walls after proper starting technique, interference may vary at the ends of the field.

35. PRECEDENCE When there is conflict between a mission and a rule, the mission takes precedence, but the current Q&A page on the web (MAKE SURE TO CHECK BACK THERE OFTEN) takes overall precedence.

36. CHALLENGE QUESTIONS/SUPPORT For official answers to questions about the Robot Game part of the Challenge, including rulings on special strategies or situations, e-mail flltech@usfirst.org (most efficient) or call 1-800-871-8326, x118 (less efficient). For best results, be sure you've read the four documents listed above, under the rule READ THIS FIRST. When e-mailing, be sure to put "Challenge" in the subject line, and please state your role on the team (member, coach, parent, mentor). When calling, please leave your contact information slowly, your role on the team, and YOUR QUESTION on voicemail. NOTE: flltech cannot support LEGO product, and does not answer questions about building or programming the robot. NOTE: The FLL International Forum is great for sharing ideas, but it is NOT A RELIABLE SOURCE OF ANSWERS about the Challenge.

37. FULL DISCLOSURE/TRANSPARENCY Since individual victory need not come at the expense of collective excellence, all official answers given to teams through Challenge support are subject to public posting in the Q&A, including answers about ALLOWABLE strategies. Also, the only documents given to the refs for reference to conduct matches and make calls are the same 4 documents you and every other team have access to all season. So if a strategy is questionable for you, chances are it will be questionable for the ref too, and guarding it until the tournament is risky.

38. COACHES' MEETING If a question does come up right before the tournament, your last chance to ask it is at the "Coaches' Meeting" the morning of the tournament. There, the head ref and the coaches meet to identify and settle any differences BEFORE the matches start. For the rest of the day, the ref's calls are final when the team leaves the table. No Q&A entries will be posted after 3 pm ET on Fridays.

Field Setup

Overview

The Challenge field is an obstacle course on a mat. The obstacles are called mission models, and the mat is called the field mat. Some of the models are secured to the mat using 3M Dual Lock fastening material. The mat must be on a smooth hard flat surface, and it must be surrounded by border walls to contain all the action.

Requirements

This step first requires that you…
have read and followed the instructions under "Surface & Borders" so you now have an official framework on which to stage your field.
have read and followed the instructions on the CD that came with your Field Setup Kit so you now have the LEGO mission models.
have the field mat and Dual Lock fastening material that came in your Field Setup Kit.

Field Mat Placement

Step 1:

Clear any and all debris off the surface you intend to put the mat on. Even the tiniest particle under the mat can give the robot trouble. Vacuum the surface if you can, and run your hand over the surface afterward. Get rid of any protruding imperfections you find.

Step 2:

Unroll the mat and position it so the image is up and the area with logos is at your lower left, at the southwest corner of your surface. See the sketch labeled Table/Mat Orientation.

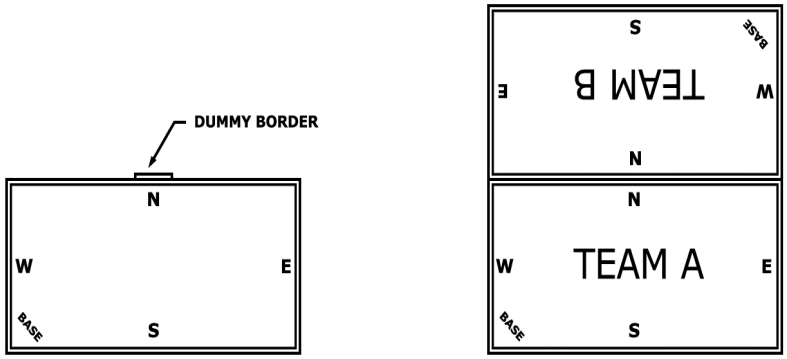
Step 3:

Slide and align the mat so that there is no gap between the "Base" corner's edges of the mat and the corresponding southwest borders. Gaps are expected and acceptable at the north and east edges.

Step 4:

With help from another person, pull the mat at opposite ends, then massage out any waviness from east to west and re-check the requirement of Step 3. It is expected that some waviness will persist, but that should relax over time.

Table/Mat Orientation



PRACTICE SETUP TOURNAMENT SETUP

Using Dual Lock

The Mission Models can be taken off the field mat for transport and storage. Some are loose, but others are secured using a re-usable fastening material from 3M called Dual Lock, which comes with the LEGO bricks in your Mission Model Set. Dual Lock is designed to stick or "lock" to itself when two faces of it are pressed together, but you can unlock it too.

When a model's placement requires Dual Lock, the model's location mark on the mat will contain boxes with X in them. For each X box, apply a piece of Dual Lock, adhesive side down, to the mat. Square pieces will need to be cut in half for the rectangular boxes. Next, press (lock) a like-sized piece of Dual Lock, adhesive side up, onto to the ones you just finished sticking to the mat.

Tip: Since the second piece of each Dual Lock pair would rather stick to you than lock to its partner, press the second piece onto the first using the wax paper the Dual Lock was supplied on, instead of your bare finger, then peel away the paper.

Finally, for each Dual Locked model, line the model up exactly over its location, being sure that all labeled features are facing as labeled. Carefully lower the model and press it down onto the Dual Lock. Try to press down on the lowest solid structure of each model instead of crushing the whole model. This application process for the Dual Lock is only needed once—later, the models can simply be locked onto the mat or unlocked.

Model Details

SPACE ELEVATOR

PLACEMENT: Use Dual Lock as shown on the mat. One space elevator model will be shared by both teams at a tournament, with each team having half the model (two of the four feet) on their mat. Since your practice table doesn't have another table next to it, you'll need to find some other way to support the far-side feet so the model stands solid and level. One way would be to nail some scrap wood to the underside of your Dummy Border, but any such staging would be fine. When placing the elevator, the car with yellow cargo can face either east or west.

OTHER SETUP: The cargo car is in the up position, and the car without cargo is locked in the down position.

ACTIVATION: When both rolling trigger arms are pushed toward the elevator, the cars should slowly trade places. To reset, simply press the car with no cargo down against the docking area.

TROUBLESHOOTING: If the cars don't move, be sure that the string is at the center of each pulley wheel. Be sure that each car is hooked to its beam, and be sure the heavier car has its yellow cargo and astronaut. Check to be sure no beam connections are loose. Check to be sure all axles spin freely. If the model won't reset, make sure both rolling trigger arms are pushed all the way toward the elevator, and the little red axles are pointing up, then try again.

FABRIC TESTER

PLACEMENT: Use Dual Lock as shown on the mat for the main body. The fabric faces Base. Be sure not to get any Dual Lock near the black diamonds. OTHER SETUP: The dirt trap is loosely placed (without Dual Lock) anywhere in Base. The eight little blue cylinders considered "dirt" in the Missions are loosely placed in the yellow dumper.

ACTIVATION: When the red beams opposite the fabric are pushed, the dumper dumps.

TROUBLESHOOTING: It is normal for some dirt to stay on the fabric, or fly out of control, depending on how fast the red beams are pushed.

MOLECULAR MOTOR

PLACEMENT: Use Dual Lock as shown on the mat. Be sure not to get any Dual Lock near the black diamonds.

OTHER SETUP: 1) Pull the rubber-band lever clockwise until the end of the rubber band is stretched past all the yellow beams. While holding that there, 2) lift the double gray axles up to the square black frame, and let go of the rubber band lever. 3) At the opposite end of the square frame, pull the black engagement lever clockwise until its 24-tooth gear meshes fully with the 40-tooth gear. 4) Slide the battery holder (black & gray) so its gear is free, lift it about two-thirds as high as possible, then slide it so its gear is meshed fully. 5) Place the battery loosely in its holder (direction doesn't matter). The two ATP (yellow) molecules are placed anywhere in Base.

ACTIVATION: When an ATP molecule is dropped or otherwise forced through the square black frame, the spinner spins, and the battery is released onto the mat.

TROUBLESHOOTING: If nothing happens when the double gray bars are weighted, you probably forgot step 3. If the battery doesn't release, check to be sure no beam connections are loose, and that all axles spin freely.

SELF ASSEMBLY

PLACEMENT: Use Dual Lock as shown on the mat for the main body. The blue side faces the east border wall.

OTHER SETUP: The gray trigger lever axle points directly downward. When looking at the model from the east, and working from right to left, rotate each blue segment counter-clockwise until the red end of the corresponding stopper arm drops down, preventing back-rotation. Then push each red stopper arm downward to be sure it's firmly in place.

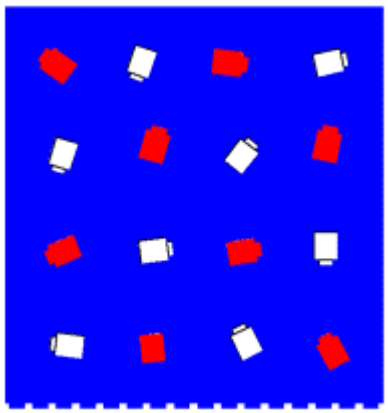
ACTIVATION: Pushing the gray trigger axle frees each blue segment to fall into place, lining up like the structure of a carbon nanotube.

TROUBLESHOOTING: If the segments don't spin freely, make sure the gray stoppers at the far side are not pinching against the model's frame, and be sure there are no loose beam connections. If the segments are not lining up with each other, one or more of them may be over-rotated. Make sure each tiny red axle stays under its stopper arm, but above the lower frame beam.

INDIVIDUAL ATOMS

PLACEMENT: Use Dual Lock as shown on the mat for the main body. The studs of the blue surface face the south border wall.

OTHER SETUP: Place the atoms (red & white) loosely on the blue surface as shown below. Always be sure the northwest atom is red. Looking diagonally, rows of each color atom should be mostly straight. Perimeter atoms should be two to three times a red atom's length from the edge. All studs face sideways (direction doesn't matter). Suggested technique: Hold the table still with one hand. Arrange the red diagonal row of four, followed by the remaining reds. Finally, place the white atoms using the red pattern as a guide.



ACTIVATION: With good technique, white atoms can be moved independently of red atoms.

TROUBLESHOOTING: If the blue surface is not level, be sure all the blue bricks are

tightly joined and that all four rubber bands under it are installed correctly. If the atoms fall due to people leaning on or bumping the field table, consider securing the table to a wall or floor.

STUCK NANOTIP

PLACEMENT: Use Dual Lock as shown on the mat. The magnet end goes toward the west border wall.

OTHER SETUP: The nanotip is stuck (the tip magnet is stuck to the fixed magnet).

ACTIVATION: With good technique, the tip can be freed (magnets separated). Separating the magnets such that the tip magnet goes below the fixed magnet is considered field damage.

TROUBLESHOOTING: If the magnets don't line up, make sure the east end of the tip axle is flush with the east side of the mounting plate. If the magnets seem harder to free than they used to be, this may be due to the tip axle relaxing downward. If so, remove the tip axle with its magnet and reinsert it upside down as needed.

CABLE TESTER

PLACEMENT: Use Dual Lock as shown on the mat. While pressing this model down onto the mat, make sure the red beam "slider" part at the mat level is free to slide north and south. Reposition Dual Lock if needed.

OTHER SETUP: Push down as far as possible on the end of the boom, near the white rubber band. This will allow the slider to reset. Next, center the lift frame (with red plates) between the gray beams and push it as far north as possible while maintaining full contact with the mat. Finally, place the truck on the mat facing north with its front wheels barely touching the gray ramps. Make sure the rear wheels are centered over the slider.

ACTIVATION: When the truck is pushed onto the lift frame, pushing the slider north will cause the truck to be lifted.

TROUBLESHOOTING: If the string tension doesn't allow proper setup, use the yellow adjuster/stopper to add or remove slack. If the lift frame won't rest flat on the mat, tighten/adjust the gray ramps, and check for incorrect Dual Lock placement/interference.

ARM BONE

PLACEMENT: Use Dual Lock as shown on the mat, with the problem spot (black piece) directly over its mark. The Buckyball (colored plastic marble) is loosely placed anywhere in Base.

ACTIVATION: When placed in the bone's channel, the green Buckyball usually rolls and comes to rest at the problem spot.

TROUBLESHOOTING: It is normal for the Buckyball to miss stopping at the problem

spot once in a while due to dimples on the ball.

PIZZA MOLECULES

PLACEMENT: The pizza (red) molecules are loosely aligned (exact alignment is not possible) on their marks on the pizza, tripod-style, as shown on the mat.

Field Maintenance

BORDER WALLS: Remove any obvious splinters, and cover any obvious holes.

FIELD MAT: Make sure the mat rests evenly at the bottom of the south and west border walls. 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, which should be expected at some tournaments. Use a vacuum and/or a damp cloth for dust and debris (above and below the mat). When moving the mat for transport and storage, be sure not to let the material bend into a sharp kink point, which could affect the robot's movement. Many consistent repetitions of rubbing on the same areas of your practice mat should be expected to cause wear in the image, but such wear is unlikely at a tournament.

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.

Project

What is Nanotechnology?

Nanotechnology is a new scientific frontier that will impact many facets of society, such as medicine, computers, and the environment. The nano world is 100,000 times smaller than the thickness of a single strand of hair. At the nano level, everything jumps and shakes – even solid things like tabletops. Imagine, the atoms that make up a solid object constantly move and vibrate!

Why Nanotechnology?

Nanotechnologists move atoms and molecules around to make amazing new discoveries. Scientists believe that someday nanotechnology will allow us to cure diseases using devices small enough to travel through the human body. Others believe nanotechnology will allow us to travel into space in an elevator using a system of tiny tubes and centrifugal force. Because of nanotechnology, right now you can buy things like stain-resistant clothes and bouncier tennis balls.

The Nano Quest robot game mission models represent just some of the technology and ideas that scientists are thinking about or working on right now. Through your Nano Quest project, you'll be asked to join the exploration of this new and fascinating world.

Nano Quest Project Summary

Project Selection: Explore a current or potential application of nanotechnology, either from the Nano Quest robot missions or from another source. Learn what scientists are

facing in improving upon the existing application or making the potential application a reality. Design an improvement for the existing nanotechnology, or choose a potential application that faces a challenge and solve it. Share your findings with your community.

NOTE: Include all three parts of the project in the presentation in order to qualify for project awards at qualifying and championship tournaments:

1) Select a current or potential application of nanotechnology
2) Design a solution or improvement
3) Share your project with others

Its length should be no more than five minutes, including setup time

Team Project Guide

Join experts around the world, researching questions and creating new technologies that will make life better for everyone. This guide helps you get started and includes suggestions and tips to make the project steps easier to follow and complete. The Coaches' Handbook also has a helpful chapter on the project. And be sure to **look for the fun in everything you do.** (Marti Wolf, FLL Coach) **You'll be amazed at what you can achieve!**

1. Select a Project:

Choose a current or potential application of nanotechnology, either from the Nano Quest robot game missions or from another source. Explore this area and discover what scientists are currently learning about it. Find out what challenges they need to solve to improve upon existing technologies, or offer brand new ideas to make a potential application a reality. Be sure to focus your project on one improvement or solution.

You can learn more by communicating with experts in the field, such as nanotechnologists, physicists or computer technologists. Methods include:

• Email experts using "ask a scientist" web sites.
• Read what experts have written.
• Study design concepts that have already been created.
• Visit your local university science or engineering department.
• Visit web sites – some are listed on the Project Resources page found on the FLL International Web site (www.firstlegoleague.org).
• Check out books, magazines, newspapers, watch television, or visit libraries.

2. Design a Solution:

Design a solution to improve an existing nanotechnology or choose a potential application that has a challenge and design a solution to make it a reality. As you design your solution, think about these questions:

• What would its purpose be?
• What problem would it solve?

• What would it look like?
• How would it work?
• How would it affect the world around you?

Combine your research and your solution into a creative presentation for your community and the judges at your tournament. Its length should be no more than five minutes, including setup time. When your team practices your presentation, use a checklist to be sure you clearly communicate all three steps.

3. Share Your Project with Others:
Share your presentation with others to teach your community what you have learned about nanotechnology. This is also a great way for you to practice your presentation for the judges. Be sure your audience has the opportunity to ask you lots of questions. Sometimes the questions you are asked will help you refine your presentation.

Ideas for practicing and sharing your presentation with your community:

• Educate your school or classmates about your research.
• Share your findings with employees at a company interested in nanotechnology.
• Practice your presentation for family and friends of the team.
• Present it to your team sponsor(s) to thank them for their support.
• Share your ideas with your town council or other government officials.
• Create a web site and publicize it to others.
• Design a brochure, poster or storyboard that others can view.

Keep a list of the people who have seen or heard about your project, and include it in your presentation to the judges.