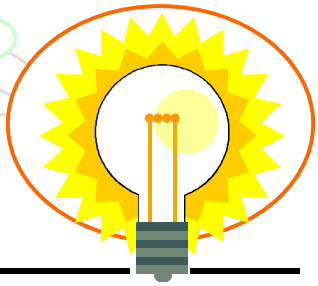
Boston Public Schools
2008 TechBoston Annual Robotics Olympics

Creative Minds



Saturday, May 17, 2008 1-5pm
Watson Auditorium
Wentworth Institute of Technology

Event sponsors:

We all know about great inventors like Thomas Edison and Leonardo Da Vinci, and the stories behind history-changing inventions such as electricity, printing press, and the telephone.

But how about the other inventors? Everything we use today – from the forks that we eat with, beds that we sleep on, to backpacks that we carry to school – were invented by someone, somewhere, at some point in time. This year's TechBoston Robotics Olympics will highlight some of the common household inventions that we use every day but may have taken for granted until now.

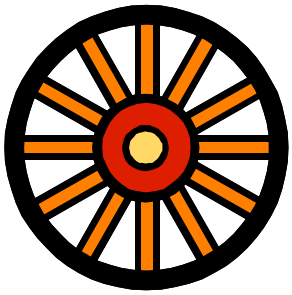
If you have any questions regarding this year's challenges and rules, please contact Haruna Tada at htada@techboston.org or 617-908-6045.

Challenge 1: Wheel On Up

Imagine how different life would be without cars, trains, bicycles, or buses. All these technologies have one thing in common – wheels. The oldest wheel ever found dates back to about 3500 B.C. in ancient Mesopotamia; however, archeologists believe that wheels have actually been in use many years before that.

The invention of wheel was not only important for transportation of people and goods, but also for many industrial innovations as well. Water wheels and potter's wheels were used from ancient days for manufacturing goods. Sewing machines, printing press, and many other industrial tools also use wheels. Modern technologies that use the principle of wheels include propellers, jet engines, and even computer hard drives.

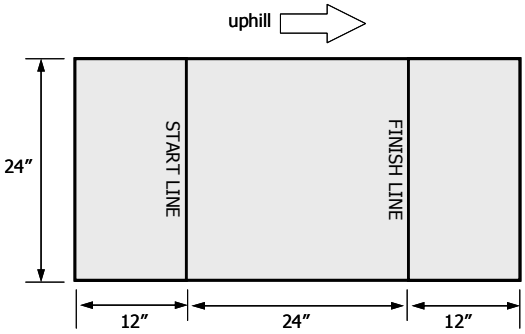
In this challenge, you will design and make a wheeled robot that can travel up steep ramps to carry some goods up to a higher ground.



Rules:

- Robot MUST be controlled using default Program 1.
- Only RCX-based robots are allowed in this challenge. NXT's can not be used.
- Robot must have at least three wheels that touch the ground.
- Robot must carry the following goods: 1) two pencils (brand-new, unsharpened #2 pencil); 2) three AA batteries; AND 3) one ping pong ball. Goods must not be attached to each other or to the robot, and must not touch the ground. They must all be carried in one trip.

- The plywood ramps measure 24" wide by 48" long with 3" high barriers around the edges. The ramps vary from approximately 20° to 45° slope, in approximately 4° increments.
- The robot must start on the ramp with all parts behind the start line located 12" from the base of the ramp. All parts of the robot must cross the finish line which is located 12" from the top of the ramp.
- Robot will begin on the shallowest ramp. If it successfully climbs the ramp while carrying all items, then it will advance to the next ramp. The robot that climbs the steepest ramp wins.
- You will get two attempts to climb each ramp.
- In the event of a tie, the robot that climbed the steepest ramp in the shortest time will be the winner.



References:
Wheel, Retrieved February 20, 2008 from http://en.wikipedia.org/wiki/Wheel
Fascinating facts about the invention of the Wheel by Mesopotamian's in c3500 BC., Retrieved February 20, 2008 from http://www.ideafinder.com/history/inventions/wheel.htm

Challenge 2: Shopping Spree

Where can you get meat, vegetables, bread, medicine, and flowers all in one store? The supermarket! Life wasn't always this convenient. Before there were supermarkets, you had to go to a butcher for meat, a bakery for bread, a produce stand for vegetables. Furthermore, shopping wasn't self-service; a clerk had to assist each shopper by measuring and packing the goods, much like you would at a deli counter today.

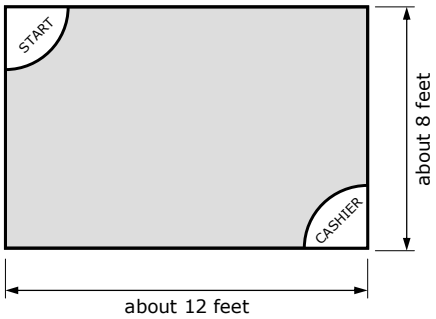
This all changed when the first self-service grocery store was developed by Clarence Saunders. The store was called Piggly Wiggly, and it opened in Memphis, Tennessee in 1916. For the first time, shoppers could get various types of items in one store, pre-measured and packaged, by simply bringing the items to a cashier at the store exit.

In this challenge, you will maneuver your robot around a supermarket to collect items. Points will be added for each item that you bring to the cashier.

Rules:

- Robot MUST be controlled using default Program 2, with touch sensors attached to ports 1 and 3 by long cables.
- Only RCX-based robots are allowed in this challenge. NXT's can not be used.
- The floor will measure approximately 8 feet by 12 feet.
  - Your robot will begin at the START area, designated in one corner.
  - There will be an area designated as CASHIER in the opposite corner.
- The floor will be marked by tape. Your robot may travel outside of the floor area.
- ITEMS, represented by 2×4 LEGO bricks, will be scattered randomly across the floor. Your task is to use your robot to bring items to the CASHIER's area. Items that are inside or touching the CASHIER area will be counted for your score.
  - Red items are worth 1 point each.
  - Yellow items are worth 3 points each.
  - Blue items are worth 5 points each.

- You will have 3 minutes to bring as many items as possible to the CASHIER's area.
- There will be some obstacles placed throughout the floor. If you or your robot move an obstacle out of place, 3 points will be deducted from the total score.
- In the event of a tie, the robot that brought the most number of items wins.
- You will get at least two trials for this challenge.



References:
Supermarket, Retrieved February 20, 2008 from http://en.wikipedia.org/wiki/Supermarket
CLARENCE SAUNDERS 1881-1953, Retrieved February 20, 2008 from http://tennesseeencyclopedia.net/imagegallery.php?EntryID=S006

Challenge 3: Perfect Trap

The mouse trap was originally invented by William C. Hooker who received a patent for his device in 1894. The mouse trap featured the familiar snap-shut design, and very little has changed in the mouse trap design since then.

The fact that the mouse trap design hasn't changed much in over 100 years is a testament to how effective the design is. It is economical, easy to make, easy to use, and most importantly, it gets the job done. If there is one flaw in the mouse trap design, it is that it kills the mouse that it captures. It would not work for someone who wishes to capture the mouse without harming it.

In this challenge, your task is to design and prototype a humane mouse trap that will catch a mouse alive and unhurt. You will demonstrate your mouse trap to judges for scoring.

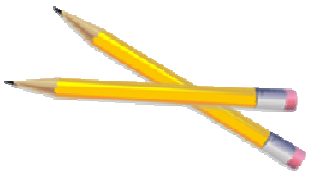
Rules:

- Mouse trap may use a RCX/NXT and electronic components (motors, sensors), or it may be made entirely out of non-electrical pieces.
- In addition to a mouse trap, you must also provide a simulated "mouse" to be used for judging. Requirements for the simulated mouse are as follows:
  - The judge must be able to ROLL the MOUSE into the trap to simulate a mouse walking into it.
  - The MOUSE does not need to resemble an actual mouse; however, it should be approximately the size of an actual mouse.
  - MOUSE may be made out of any material, including non-LEGO material.
  - You may NOT bring a real mouse or any other live animals.
  - Suggestions include small toy car or a golf ball.
- The mouse trap must satisfy the following design requirements:
  - The device must capture a MOUSE. The MOUSE must be captured in such a way that it does not escape when the mouse trap is shaken, tilted, or lifted.
  - The device must not harm the MOUSE. It must not exert any excessive force on the MOUSE (as determined by the judge).
  - Once captured, the user must be able to release the MOUSE to set it free without touching the MOUSE.
- There is no size limit on the mouse trap; however, keep in mind that this is a prototype of an actual mouse trap, and that most people probably would prefer a compact trap.

- The mouse trap will be judged based on the following:
  - Did it meet all design criteria?
  - Overall construction quality – robustness, repeatability.
  - Ease of use – how easy is it to set and to release the mouse?
  - Concept – would it work in real life, with a real mouse?

References:
Mousetrap, Retrieved February 20, 2008 from http://en.wikipedia.org/wiki/Mouse_trap
History of the Mousetrap, Retrieved February 20, 2008 from http://inventors.about.com/od/mstartinventions/a/mousetrap.htm

Challenge 4: Penciling In



Pencils have become such a familiar object in everyday life, especially in schools. You probably can't get through one class without using a pencil. That wasn't always the case.

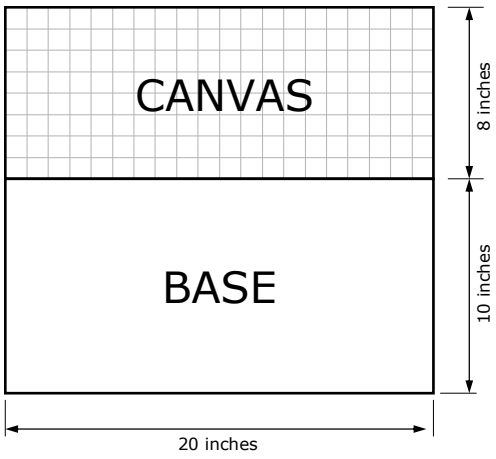
Pencils were first invented in Great Britain in early the 1500's. Early pencils consisted of a solid piece of graphite which was cut into a stick. The graphite was then wrapped in string or sheepskin for stability and strength. The design of the pencil evolved in the next few hundred years, with the addition of a wooden holder, use of powdered graphite held together by clay which allowed pencil lead of various hardness to be produced, and finally the addition of an eraser in 1858.

It wasn't until much later that pencils became an everyday object for homes, businesses, and schools. Wide spread use of pencils became possible when, in the late 1800's, Joseph Dixon of Sturbridge, Massachusetts discovered a way to mass-produce pencils.

In this challenge, you will design a robot that will use a pencil to make marks on a piece of paper. The more marks you make, the more points you get!

Rules:

- You will supply your own sharpened pencil for the challenge. The pencil may be secured to your robot using LEGO's, masking tape, and/or rubber bands (other methods of attaching pencil to robot are not allowed).
- The pencil must be a standard No.2 pencil, but may be of any length.
- The robot may use ONE pencil only.
- The robot must start entirely in BASE, which measures 20 inches by 10 inches (see figure below). You may touch the robot only when it is in BASE.
- You have 2 minutes to make your robot write as many marks on the CANVAS as it can.
  - The robot may make all the marks in one sweep, or it may return to BASE (robot must be entirely in base) to be re-aimed.
- The CANVAS, which measures 8" by 20", will be marked with a 1 inch grid.
  - You will receive 1 point for each grid that has a pencil mark in it.



  - You will receive 2 additional points for continuously marking a vertical column of 8 squares.
  - You will receive 5 additional points for continuously marking a horizontal row of 10 or more squares.
- The robot may travel outside of BASE and CANVAS areas. There will be AT LEAST 10 inches of space on all four sides for robot to travel on.
- If the robot must be retrieved when it is not entirely in base, 5 points will be deducted from your score each time.
- Up to three motors may be used for this challenge.

References:
Pencil, Retrieved February 20, 2008 from http://en.wikipedia.org/wiki/Pencil
History of the Lead Pencil, Retrieved February 20, 2008 from http://www.officemuseum.com/pencil_history.htm

Challenge 5: Flying Saucer

Not all inventions have huge industrial or technological impact on society. Many inventions involve "play," an important aspect of human life.

The origin of the Frisbee dates back to the early 1900's when college students in New England used empty pie tins from the Frisbie Pie Company to toss around and catch. The first plastic disk produced specifically for recreation was designed by Walter Frederick Morrison and Warren Franscioni in 1948. The toy finally gained popularity in late 1950's when Richard Knerr took Morrison and Franscioni's toy, then called the Pluto Platter, and re-marketed it as a new sport under a new name, "Frisbee," after the original pie tin.

Since then, the Frisbee has become a very popular pastime among children and adults (and even pets!) and an internationally recognized sport.

In this challenge, you will design a robot that will throw a "disk" as far as it can.

Rules:

- A standard CD, measuring approximately 12 cm (4 ¾ inch) in diameter, will be used as the DISK. The CD may not be altered in any way.
- The DISK may be loaded on to the robot by hand. You will activate the launch by pressing the Run button on the RCX or NXT.
- Robot and DISK must start entirely behind the START line. The robot must remain behind the START line at all times.
- The CD must be released no more than 30 seconds after you press the RUN button on the RCX or NXT. You may not touch the robot or the CD after pressing the RUN button.
- Distance will be measured from the START line to the closest edge of the DISK after it has come to a complete stop.
- Intentional rolling of the DISK is not allowed.
- You will get at least two chances to launch the DISK. The best score will be used.
- The robot may not break the DISK. Breaking the disk will result in disqualification. (Slight scratches are allowed.)

References:
Flying disc, Retrieved February 20, 2008 from http://en.wikipedia.org/wiki/Frisbee

Challenge 6: Squared Away

Many times, an invention involves a process or method for making a product, not the product itself. Such inventions are often the key in making the product more readily available to people at a lower cost.

In 1873, Margaret Knight, a Massachusetts woman, invented a machine that made square-bottomed paper bags, much like supermarket paper bags or lunch bags that you see every day. Square-bottomed bags existed before then but no one knew how to manufacture them quickly in large quantities. Similar machines are still in use today for making paper bags.

This wasn't Margaret's only invention. She is known as "the female Edison," and has over 25 patents covering a wide range of applications.

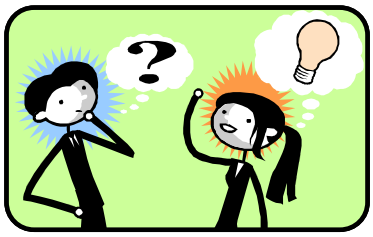
Thanks to Margaret's invention, paper lunch bags can now stand upright. In this challenge, you will design and make a robot that can fill a paper lunch bag with various items.

Rules:

- Lunch bag will be placed on a table upright, but not secured.
- The lunch bag measures approximately $5\ ^{1}/_{8}$ by $3\ ^{1}/_{8}$ by $10\ ^{5}/_{8}$ inches (13 × 7.9 × 27 cm).
- The following items will be provided:
  - 10 ping pong balls (3 points each)
  - 6 golf balls (5 points each)
  - 3 tennis balls (10 points each)
- You will have three minutes to move as many items into the bag as possible.
- You may load the items onto your robot by hand, but only when the robot is not running. You will then press the RUN button on the robot, and the robot must place the items into the bag.
- Robot may be placed anywhere around the paper bag, but no part of it may not be inside the paper bag when you start the robot.
- You may re-position and adjust the robot only when it is not running and it is not touching the paper bag.
- You may move multiple items at a time if you wish.
- You may place other items in the bag if you wish. However, these items must be placed by the robot and follow all other rules regarding setup and starting. Extra items will not count for any additional score.
- Lunch bag must be upright at the end of the three minute trial. (You may tip the bag over and move it back to its upright position at the end IF these actions are done by the robot.)
- If the bag falls over at any point and cannot be recovered by the robot, only items that were placed into the bag BEFORE it fell over will be counted for points.
- Lunch bag may not be altered or damaged in any way.
- Please note the ROBOT SIZE rule (Rule #1) in the general rules.

References:
Women's History Month: Prolific Female Inventors of the Industrial Era, Retrieved February 20, 2008 from http://web.mit.edu/invent/iow/whm2.html
Margaret E. Knight, Retrieved February 20, 2008 from http://en.wikipedia.org/wiki/Margaret_E._Knight

Challenge 7: Mystery Challenge



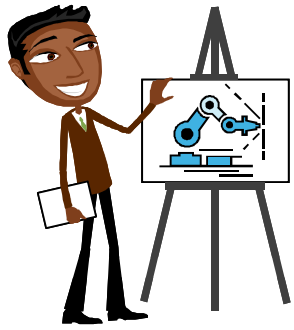
Inventors are constantly exercising their creative minds, looking for new problems and solving new challenges.

For this challenge, teams of students will work on a mystery problem that will be unveiled at the Robotics Olympics. The team will then have two hours to solve the problem.

Rules:

- Teams MUST consist of two or three students. At least one student should know how to program using ROBOLAB Inventor.
- Teams will be provided with LEGO materials to use. Pieces other than those provided are not allowed. Teams will be provided with RCX's (not NXT's).
- Teachers, parents, and other students may observe, but not help, the student teams. There will be an experienced helper available in case teams need some guidance.
- ONLY ONE TEAM PER SCHOOL IS ALLOWED IN THIS CHALLENGE.
- Each team must bring a computer with ROBOLAB software installed. If you don't have a laptop that you can bring, please contact TechBoston well in advance to make necessary arrangements.

To prepare for this challenge, try solving other challenges from Robotics Olympics or FIRST LEGO League (previous years' challenges are available upon request). Practice working under time constraints by completing the challenges in less than two hours.



Challenge 8: Poster Presentation

Do you have an idea for a new invention or an improvement on an existing product?

This is your opportunity to show your robotic invention to a panel of judges through a poster presentation.

Rules:

- Poster presentation may accompany any entry in Challenges 1~6, or it can be about an original invention that addresses any need or problem.
- Poster presentation must be accompanied by a prototype of the invention. The prototype must be made out of LEGO's but may contain other items (such as paper, tape, etc.).
- Prototype may be of any size. There is no limit to the number of RCX/NXT, sensors, or motors for the prototype.
- Posters must use the tri-fold Science Fair poster board.
- Students will present to judges for 3 minutes, then answer questions from the judges.
- Poster should include the following:
  a) Title, name(s) of student(s), and name of school.
  b) Problem or Challenge solved.
  c) Design ideas & robot features, including both building and programming aspects.

d) What type of testing and redesign was done to the robot.

e) Screenshot of the program should be on the poster if possible.

- Scoring will be based on:
  - creativity of the idea
  - quality and organization of the poster
  - building/programming of the robot.

General Rules:

The following rules apply to ALL challenges unless otherwise specified in the challenge description:

1. ROBOT SIZE: Unless otherwise specified in the challenge description, a robot must not exceed 10" by 8" base and 8" height at the starting position (it may "grow" to a larger size after deployment).
2. Any genuine LEGO piece may be used in the construction.
3. Unless otherwise specified in the challenge description, robots may not contain any non-LEGO components. Tapes, strings, etc. are not allowed. Exceptions are:
   - Non-LEGO rubber bands may be used only if they are used as part of a pulley system.
   - Tapes or labels are allowed if used only for identification purposes.
4. Unless otherwise specified in the challenge description, robots may have a maximum of:
   - 1 RCX or NXT
   - 2 motors
   - Up to 3 sensors (any combination of touch sensor, light sensor, rotation sensor). Built-in rotation sensor on NXT is counted as part of 3 sensors ONLY IF the rotation sensors are used in the programming.
5. If a robot breaks during competition, the following procedure will apply:
   - Student will pick up the robot and remove it from the field.
   - Student may fix the robot him/herself or take it to the Help Desk to get help fixing it. Help Desk will have extra parts and experienced builders who can help fix the robot.
   - After repairs, student may re-attempt the challenge ONCE from the beginning.
   - The student will have no less than 10 minutes to fix the robot. More time may be allowed if time permits.
   - If the robot breaks in the second attempt, the attempt ends and the score will be given based on what the robot has completed before it broke.
6. Because some events run concurrently, each student may participate in only one event (with the exception of Challenge 8, which can be combined with Challenges 1~6).