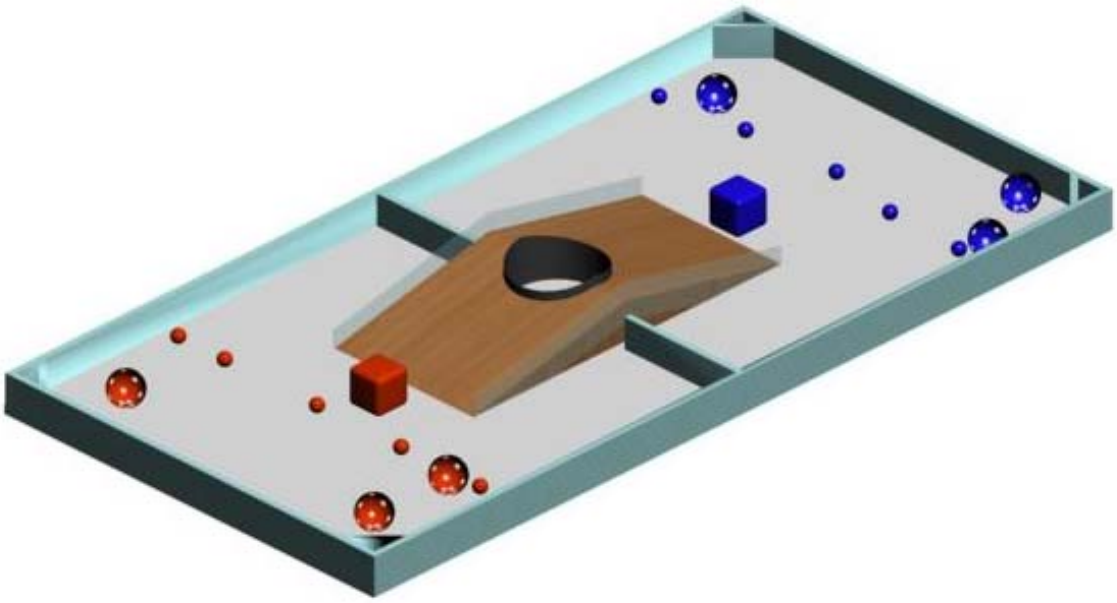
Gears Educational Systems, LLC
GEARS-EDS . . . technology education in a box

Gears LLC 105 Webster St. Hanover Massachusetts 02339 Tel. 781 878 1512 Fax 781 878 6708 www.gearseds.com

Pit Boss

A **GEARS-IDS** Classroom Engineering Challenge



Pit Boss is an action packed robotic competition played on a 4 x 8' plywood field. This engineering challenge requires students to design and build robotic mechanisms capable of manipulating and delivering 3 different objects up an incline and into a 10 inch diameter "Scoring Pit"

Note: There are hundreds of possible games that can serve as exciting engineering challenges. This game is offered by GEARS-IDS because it has been used successfully in classroom settings. The inclined ramp, scoring pit and lifting requirement add additional engineering challenges whose solutions require the use of most of the GEARS-IDS kit components, and capabilities.

Pit Boss is a task-oriented challenge that encourages "Robust Robotic Interaction" at the Scoring Pit. Download a video preview of the game from Video section of the GEARS-IDS website.

Materials and Equipment

Building Materials
1 pc 4 x 8 x ½" BCX or better plywood
2 pc 18 x 26" x ¼" Luan plywood
3 pc 1" x 6" x 30" pine boards
4 pcs 1/8" x 4" x 2' lexan or acrylic
1 pc 6" x 36" aluminum flashing
2 pc 1 x 4" x 8' pine board
2 pc 1 x 4" x 4' pine board
2 pc 1 x 4" x 16" pine board
4 pc 1 x 4" x 12" pine board

1 Can Blue Spray Paint
1 Can Red Spray Paint
1 Quart White Exterior Latex Paint
1 Set of Saw Horses or a Sturdy Table
1-1/4 " deck screws
1" Brad nails
Duct Tape
Wood Glue

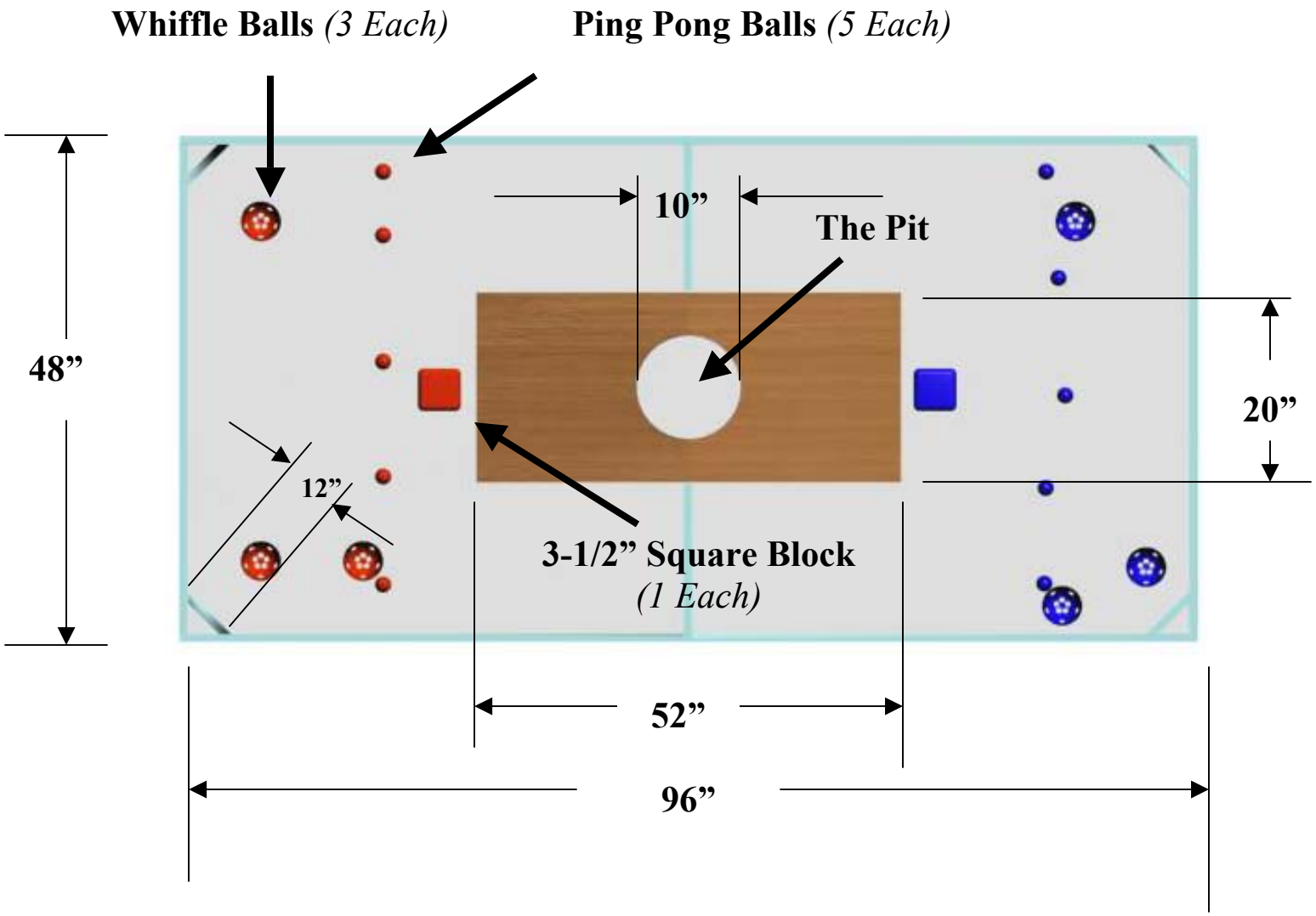
Playing Pieces
6 3-1/2" Plastic Whiffle Balls
2 Ping Pong Balls
2 3-1/2" Wooden Blocks

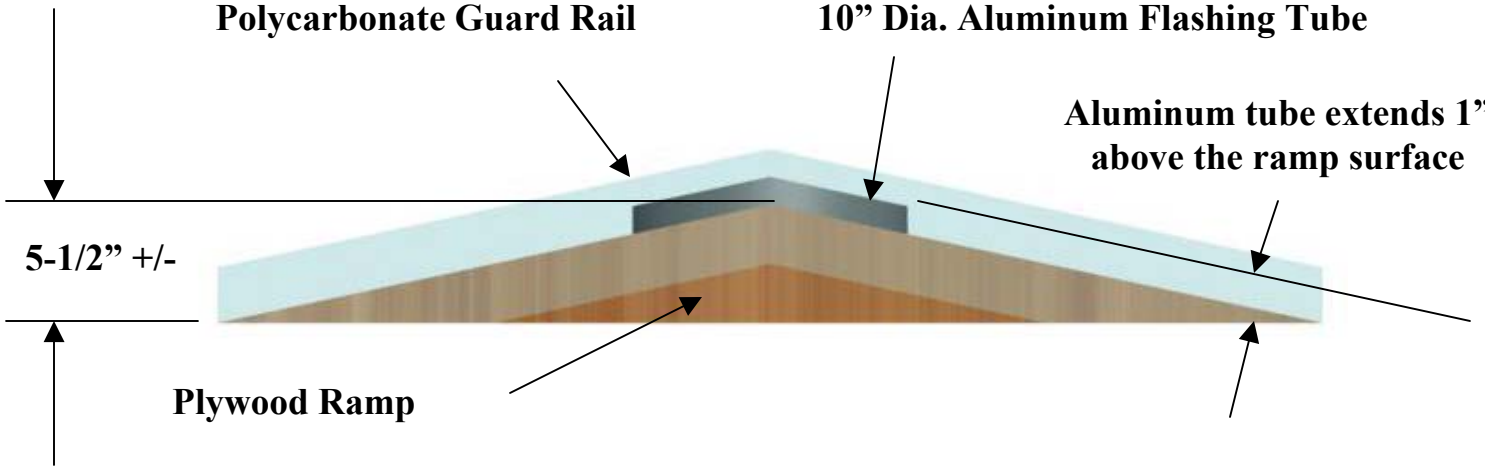
Playing Field Assembly

1. Secure the 4 x 8' plywood to a set of sawhorses or place it on an existing table top.
2. Glue and screw the 4' and 8' (1 x 4") pine boards along the edges of the plywood sheet. Cit will be necessary to cut and fit the boards. *Refer to the plans and dimensions.*
3. Cut and fit the 1 x 4" x 12" pine corner boards
4. Cut 6 triangular shaped ramp supports using the 1 x 6" x 26" pine boards.
5. Using brad nails and glue, secure the triangular ramp supports to the two 18" x 26" x ¼ plywood ramps. Allow the glue to set overnight.
6. Roll the aluminum flashing into a 10" diameter tube and tape the seams with duct tape.
7. Using the aluminum flashing tube as a guide, place the ramp sections together and trace a cut line onto the center of the ramps. Use a jig saw to cut the elliptical section from the ramp.
8. After the ramp sections have been cut, secure them to the center of the plywood table top by screwing through the triangular pine supports and into the ½" plywood. Be careful that the screws do not go through the plywood and into the table below.
9. Place the 10" Aluminum tube into the cut out section of the ramps. Using a marking pen and a gauge block, trace a line around the tube that is 1" above the ramp at all points.
10. Use a pair of aviation shears to cut the flashing along the line. Use duct tape to cover the sharp edged metal that is left. The 1" lip on the rim of the aluminum tube requires the contestants to develop lifting strategies in order to score and prevents robots from simply pushing the game pieces into the scoring pit.
11. Use duct tape to create a smooth transition between the bottom lip of the ramp and the 1/\2" plywood.
12. Cut and fit the center dividers sing the ¾" x 4" x 16" pine boards. Glue and screw them to the plywood playing surface.
13. Paint the playing pieces.
14. Paint the playing field and ramps. For added traction add clean dried washed sand to the paint.

Gears LLC 105 Webster St. Hanover Massachusetts 02339 Tel. 781 878 1512 Fax 781 878 6708 www.gearseds.com

Top View of Playing Field and Pieces





Side View Of Ramp

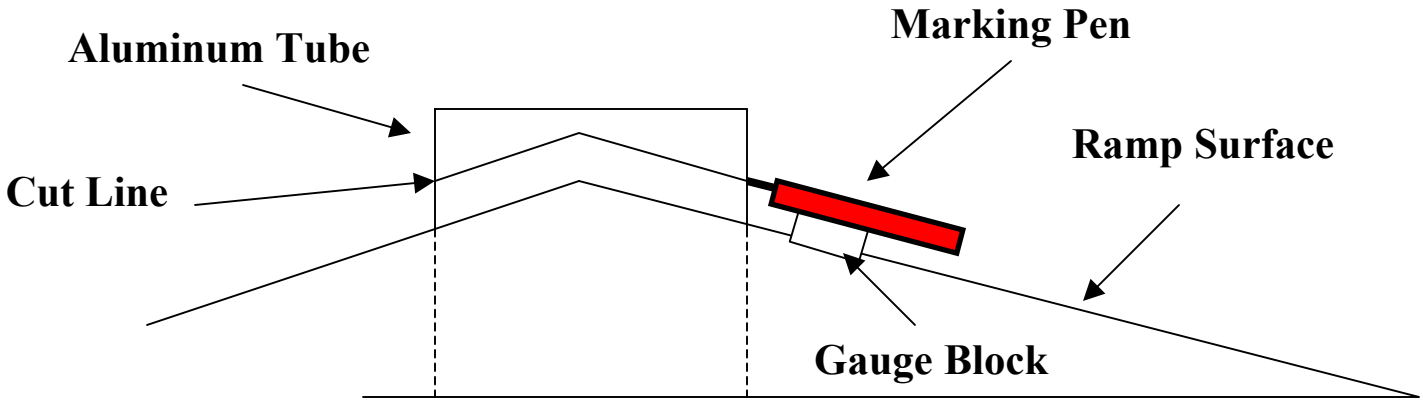
Gears LLC 105 Webster St. Hanover Massachusetts 02339 Tel. 781 878 1512 Fax 781 878 6708 www.gearseds.com

Field Construction Considerations

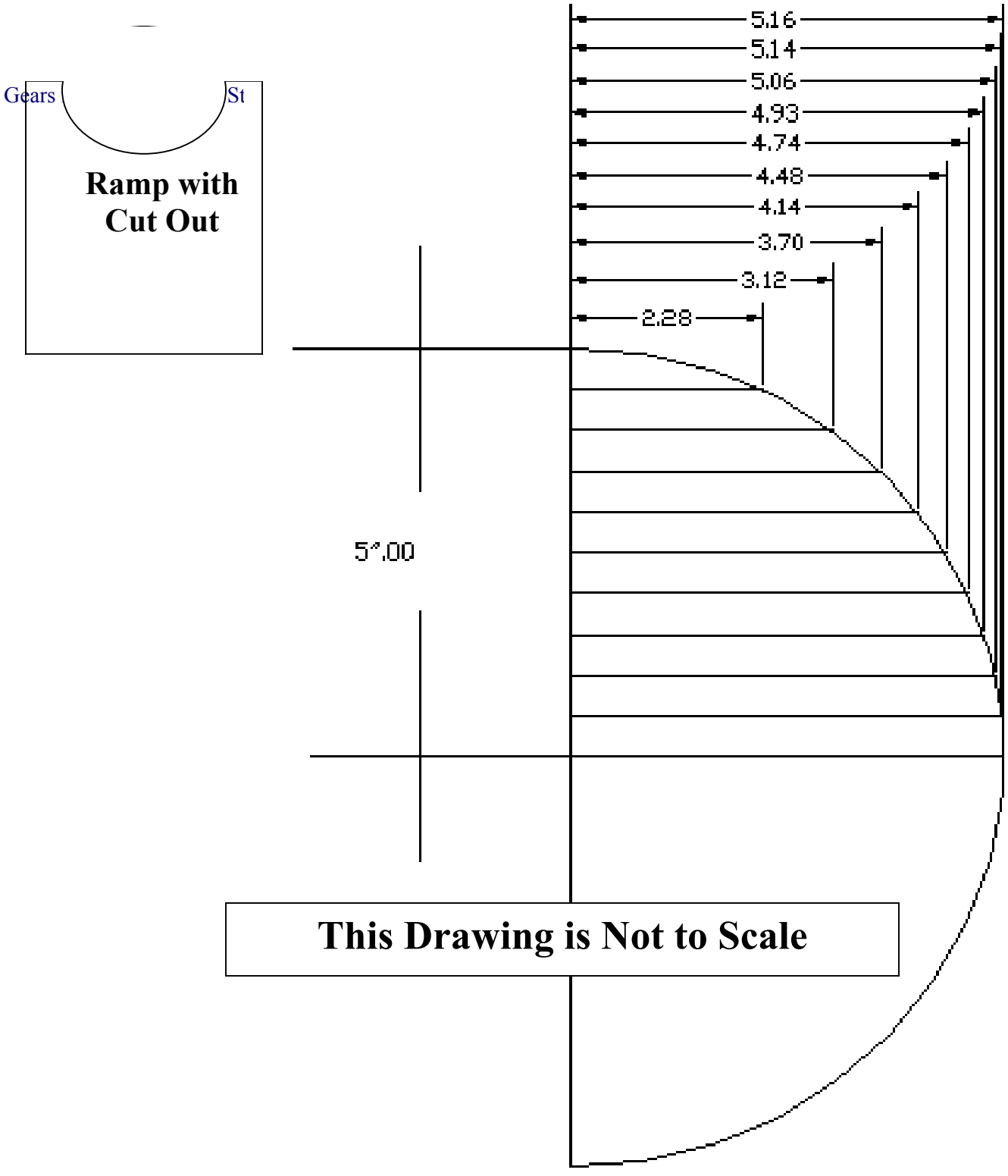
The specifications given for the playing field and pieces provide standards for those schools and classrooms that intend to host robotic leagues and establish inter and intra scholastic competitions. Students and teachers who do not intend to establish a competitive league can use these plans as a starting point from which to develop their own games with unique scoring and playing strategies. Many schools choose to develop a new game every season, and often involve the students in the process of designing the game.

Consider these suggestions when building this playing field, or creating you own game;

- The inclined playing surface adds additional engineering considerations and creates opportunities to learn about tipping moments, tractive forces and the importance of ground clearance. The Pit Boss game ramp is angled about 12 degrees from the horizontal. This incline proved to be a worthy challenge. Overly steep inclines could serve to diminish the quality of play for novice engineers who have little or no experience with the destabilizing effect of inclines over 20 degrees.
- The transition from the base of the ramp to the horizontal playing surface must be seamless. In order to prevent sheet metal end effectors from "Catching" under the ramp, it is advisable to cover all seams with duct tape. Cover the seams first, then paint the playing field.
- Polycarbonate makes an effective guard rail that prevents robots from hanging up on the edges of the ramps. Polycarbonate and other high tech material "Drops" can be freely obtained from local sign shops. Poly carbonate is tough and highly fracture resistance. Acrylic looks very much like polycarbonate but is far more brittle and easily cracks and breaks. One easy way to distinguish between thin samples of polycarbonate and acrylic is to cut a 1" wide x 6" long strip. Wearing safety glasses, begin bending the test sample. Polycarbonate will continue to bend without breaking, while the acrylic will likely snap or shatter and send small pieces flying about the room.
- The aluminum cylinder used for the "Scoring Pit" is fabricated from 0.030 aluminum flashing that has been rolled into a 10" diameter tube and taped in place. Light gauge aluminum flashing is commonly available at local hardware stores. Use a gauge and an indelible marker to trace a cut line around the cylinder. Remove the cylinder. See the illustration below.



- The aluminum cylinder is perpendicular to the surface of the playing field. The intersection of the aluminum cylinder and the ramp does not form a circle, rather it forms an ellipse. An approximation of this elliptical intersection is shown below. The dimensions are spaced ½" apart. Use these dimensions to create a paper pattern that can be transferred to the ramp. Use the paper pattern to trace a cut out for the intersection between the cylinder and the ramp.



Game Rules

The object of the game is to place as many of your playing pieces as possible in the scoring pit within a three minute time period.

Scoring

Playing pieces that are within the boundaries of the scoring pit after the three minute game time ends can be considered scores. The boundaries of the scoring pit extend infinitely upward from the outer circumference. This means that a playing piece captured by a robot and held above the scoring pit in such a way that the geometric center is judged to be inside the extended boundaries of the cylinder will be considered as a score.

The score values for the playing pieces are as follows:

Blocks	=	5 points
Whiffle Balls	=	3 points
Ping Pong Balls	=	1 point

In the event of a tie game, the robot that has scored more ping pong balls will be considered the winner. The second tie breaker will be decided by the flip of a coin.

Game Time

Each game will last 180 seconds (3 minutes). Every game will have a designated referee and timekeeper. The referee will decide all judgment calls and his/her decision will be final. The time keeper will call out the minutes of playing time left. During the last minute the timekeeper will call out the remaining time every 15 seconds. The timekeeper will count down the final 10 seconds.

The referee will ensure that each participant is ready before the match is started.

Postponements

Any participant or participating team can ask for 1 postponement before their match is started. The decision to grant the postponement lies with the opposing team. The postponement may result in a rescheduled match at another time. In the event that few or no matches remain, then the time out of up to 20 minutes may be granted by the opposing team. There is no option for a second postponement for any given match. Robots that fail to start the match after receiving a postponement will forfeit the match.

Robot Interaction

The robots play on separated playing fields. This is done to minimize interference while the robots are harvesting the game pieces. However, it is expected that the robots will interact vigorously at the scoring pit.

Robots cannot erect a permanent block, or attempt to cover the scoring pit in an effort to prevent their opponent from scoring. Robots that attempt to cover or block the scoring pit for **more than 10 seconds** will be removed to the far right corner of their playing field by the referee.

Robots that become entangled, or trapped by the playing field in any way will be freed and removed to the far right corner of their respective playing fields.

No robot will be allowed to damage the playing field. In the event that a robot design causes damage to the playing field, it will be disqualified.

A robot cannot enter the opponents area of the playing field and attempt to harass them or interfere with their efforts to gather playing pieces.

Robots will not be allowed to intentionally damage or disable an opponent. It is likely that a robot may be overturned or damaged as a result of attempting to score or prevent a score. This will be considered "Normal interaction". All judgment calls will be decided by the referee in charge of the game.

Special Considerations

- In the event that a playing piece is pushed off the table by the action of either robot, it will stay off the table and out of play for the remainder of the match.
- Only the referee may interact with the robots after the match has started.
- Participants are allowed to work on their robots after the match has begun. Often they may need to recharge the pneumatic reservoir or replace or repair damaged components. AT NO TIME CAN A PARTICIPANT OR A SPECTATOR RECH INTO THE PLAYING FIELD.
- In the event that a participant or a team wishes to inspect or repair their robot during a match, they can request that the referee hand them their robot. The referee will then shut off the robot and hand it to the players.
- In the event that a situation arises that is not clearly governed by the rules, then the participants will consider their options and make amendments to the rules. All amendments to the rules should attempt to promote parity and the spirit of good sportsmanship and fair play for everyone.

Robot Construction

The robots will be limited by weight, power and the number of control channels they are allowed to use. Limiting maximum power and capabilities serves to place the competitive emphasis on successful and innovative design and focuses student efforts on accurate control and the development of driving skills and game playing strategy.

While it is possible to build a competitive robot using only the GEARS-IDS kit of parts it is . The GEARS-IDS kit was deliberately designed and built with components

- Robot weight will be limited to 12 lbs.
- Battery Capacity is not to exceed 1.5 Amp Hours (rated) using Lead Acid Batteries.
- Robots can utilize up to 6 channels of control.
- All robots shall employ one pneumatic actuator.
- Only the GEARS-IDS gear head motors can be used to power the robot drive trains.

A Word About the GEARS-IDS Kit of Parts

- The GEARS-IDS kits are designed with robust motors and heavy gauge metal components. Unlike typical plastic or light gauge metal toy construction kits, the GEARS-IDS kits are specifically designed

to be rugged enough to accept additional real world components and a variety of engineering findings. Students are encouraged and expected to build creative competitive designs using additional found parts. Typical parts include wheels, additional materials such as PVC pipe sections, polycarbonate, aluminum flashing, string, rubber bands, wood dowels, gears, pulleys and parts from broken toys or damaged computer printers and photocopiers.

Classroom Considerations

GEARS Educational Systems recognizes that the overriding purpose of robotic competitions is to enhance learning through full participation in exciting and engaging involvement. Moreover, success is the best motivator.

Moreover, the construction of a complex machine capable of accurately retrieving and scoring a variety of playing pieces, as well as moving about on an inclined surface is a worthy challenge for any high school engineering student.

For this reason it is strongly recommended that all students be required to build the same robot base. Participating students and teams can download the "Build a Mobile Chassis" instructional manual from the Projects section of the GEARS website.

After building a sturdy, robust platform, students can be encouraged to exercise their engineering creativity to design, test and build grasping, lifting and scoring mechanisms. Teachers will be pleasantly surprised at the variety of solutions that their students will invent.

Involving students in engineering challenge games provides contextual learning opportunities. Teachers can use robot games as the focus for lessons in the following areas:

Cadd Design
Engineering Design Process
Geometry
Algebra
Mathematical Modeling
Physical Science and Physics
Communication Skills
SCANS
Materials Science
Simple Machines
Work, Power and Energy
Electricity
Electronics
Micro controllers and Programming
Measuring
Pneumatics and Fluid Power
Motors and Batteries
Mechanics
Fabrication and Tools
Safety
Scheduling and Organization
Record Keeping and Spreadsheets
Sharing Skills and Knowledge

A Suggested Educational Outline for Robotic Game Challenges.

Engineering Drawing and Design

1. Using Drawing Tools (CADD workstations or drafting tools)
2. Precision Measurement (Dial Calipers, scales and vernier gages)
3. Multi View Drawings
4. Dimensioning
5. Solid Models and Pictorial Drawings
6. Assembly Drawings

7. Possible Assignments:
Produce detailed drawings of the playing field.
Produce working drawings and solid models of the GEARS-IDS kit components.

Engineering Design Methodologies

1. The Engineering Design Process and the Scientific Method
2. Bench Level Experiments
3. Testing and Evaluating Ideas

Possible Assignment

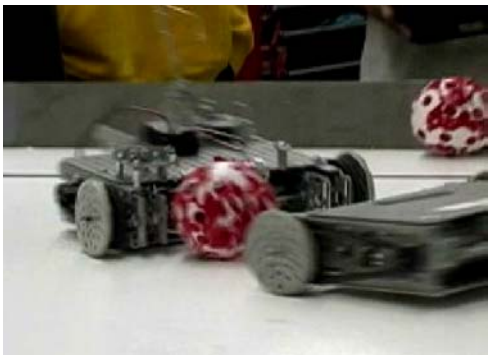
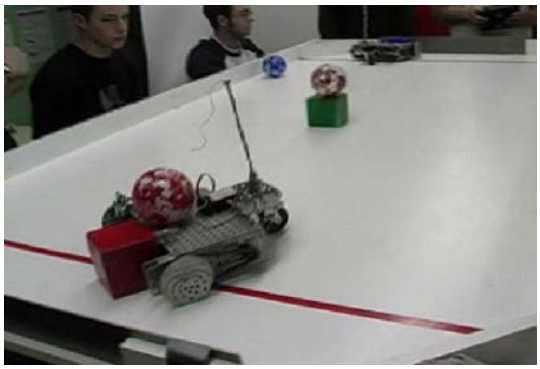
Build a pneumatic test module to experiment with pneumatic powered mechanisms and systems. You can download a detailed instructional manual for this purpose from the project section of the GEARS website at www.gearseds.com

Build a Mobile Chassis

1. Screw Threads and Fastening systems
2. Gear Ratios
3. Work and Power
4. Friction and Traction
5. Speed and Velocity
6. Basic Electricity
7. Robot Control Systems
8. Motors and Batteries

Possible Assignment

Download the Mobile Chassis instructional manual from the project section of the GEARS website at www.gearseds.com
Divide Students into teams of 2-3 members
Create a simple game using only the mobile chassis to push and move game playing pieces. See the examples below.

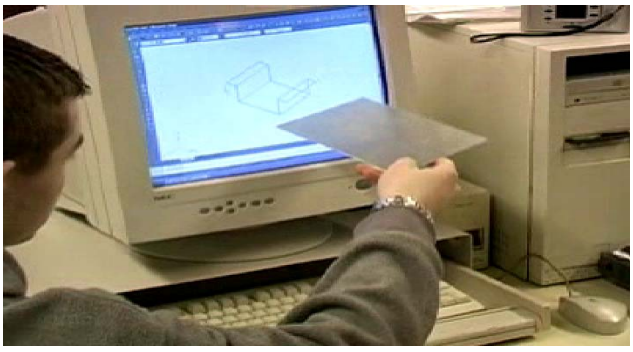
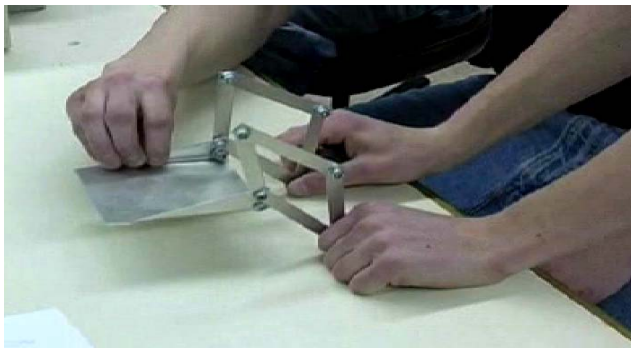
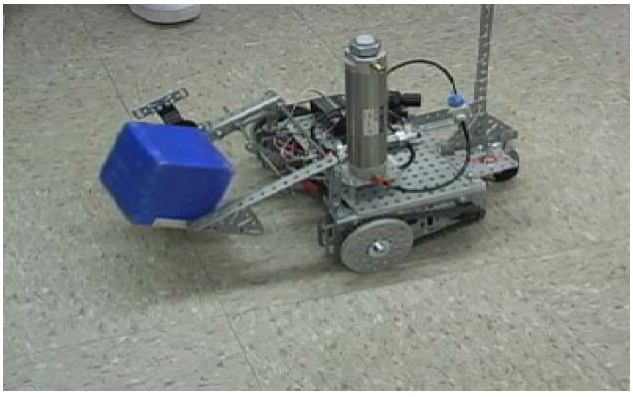
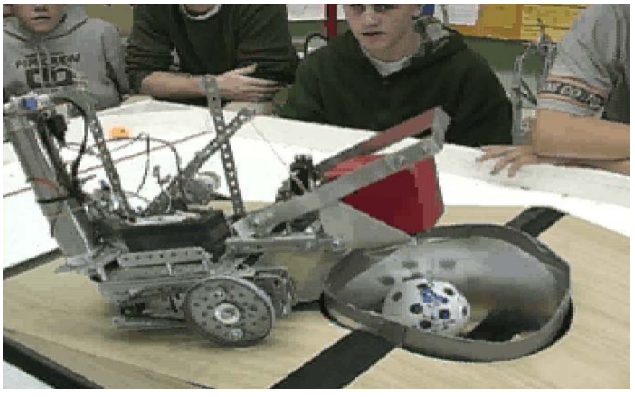
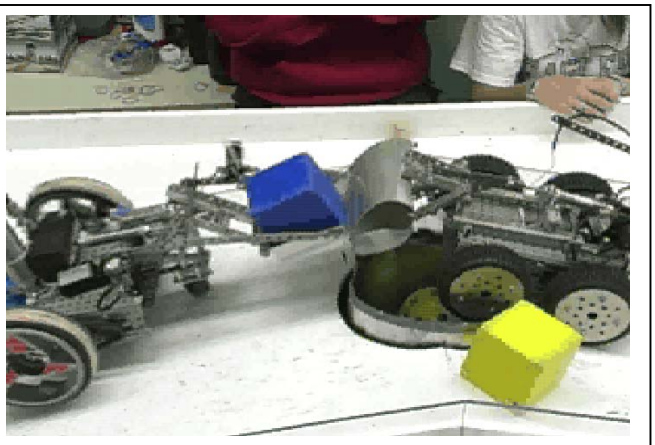
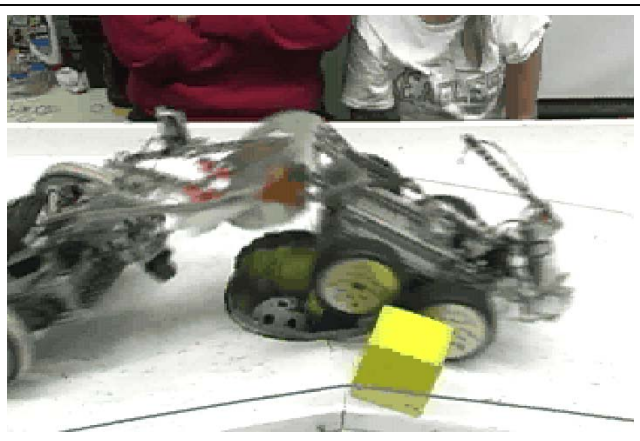





Design and Build a Scoring Mechanism

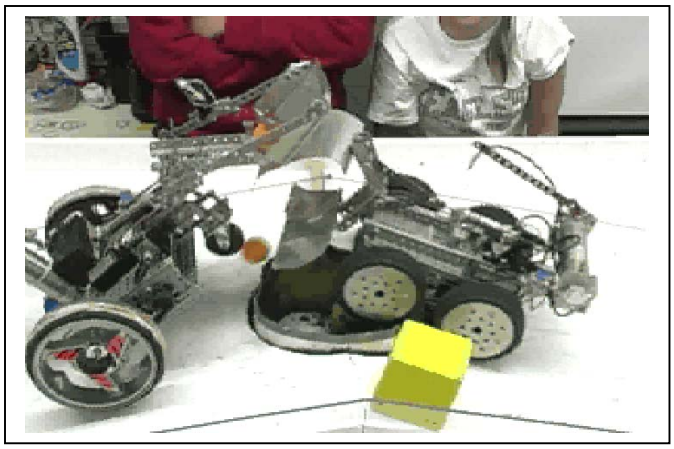
1. Components and Modules and Systems
2. Pneumatics and Fluid Power
3. Mechanics and Mechanisms
4. Animation
5. Materials and Material Science
6. Simple Machines and Mechanical Advantage
7. Force and Pressure
8. Forces and Torque

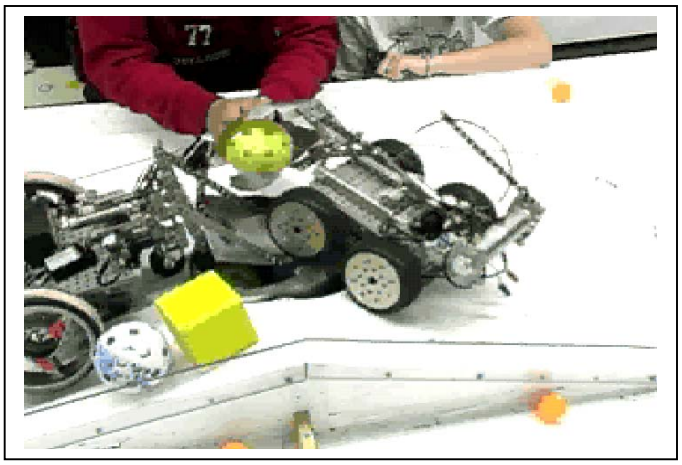
Possible Assignment

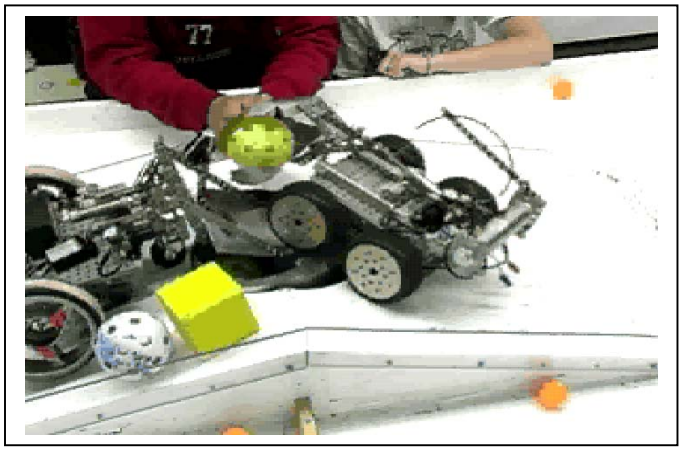
Design and build a pick up and release mechanism using the GEARS-IDS Pneumatic components and servos, in conjunction with other engineering findings that students are able to obtain.

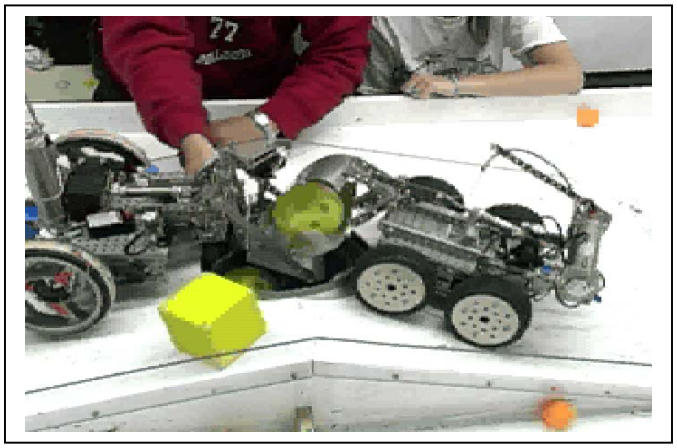







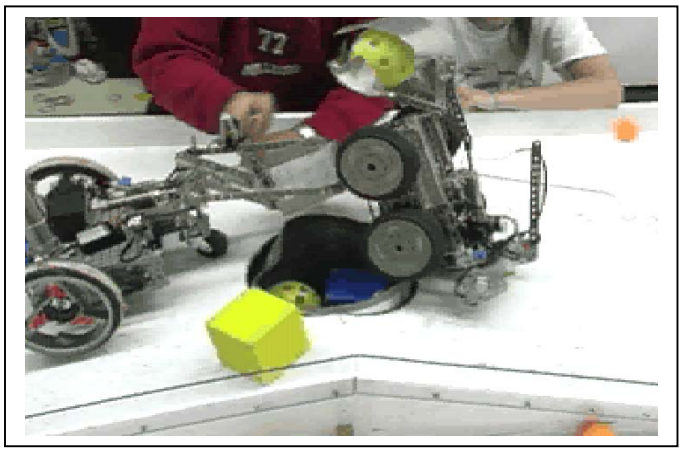
Gears LLC 105 Webster St. Hanover Massachusetts 02339 Tel. 781 878 1512 Fax 781 878 6708 www.gearseds.com

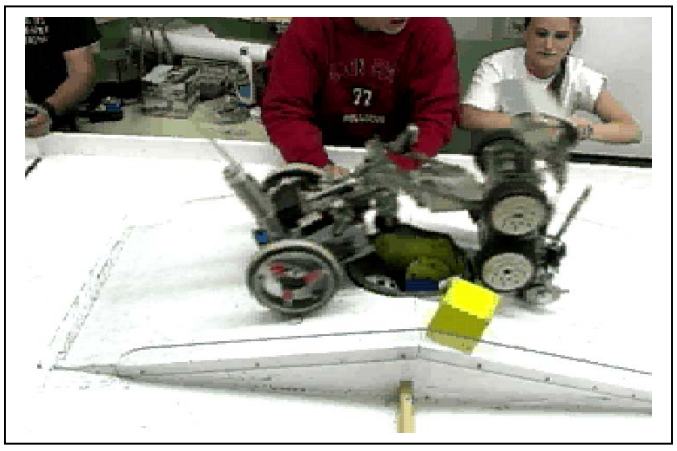












This series of pictures illustrate that learning and using engineering skills to play engineering games can add a fun and exciting dimension to any science, technology or math program. GEARS-IDS supports and promotes engineering as sport and entertainment, and we believe that we make the best classroom engineering education sports equipment available.

We at GEARS Educational Systems urge teachers and administrators to involve their students in engineering sports as an engaging way to apply the academic expertise they worked hard to achieve.

Work hard, play hard, and learn more about engineering with GEARS-IDS products and classroom support materials..and by all means, play safely!

Gears LLC 105 Webster St. Hanover Massachusetts 02339 Tel. 781 878 1512 Fax 781 878 6708 www.gearseds.com