Challenges

Part of the beauty of the VEX Robotics Design System is the ability to build robots to complete various challenges. These challenges can be self created or you can use one of many pre-existing challenges. Challenges can range from a specific task (build a robot to navigate a maze) to an entire game (build a robot to play soccer). There are no limitations to the type of challenges you can create. As you become more experienced with the VEX Robotics Design System, use your creativity to come up with more complex and advanced challenges.

For information on VEX Robotics competitions and leagues in your area, please visit www.robotevents.com.
Challenge #1 – Robot Drag Race

Description:
The challenge is to create a robot which can cross a 10 foot stretch in the least amount of time possible. Race multiple robots against each other, or play against the clock.

Equipment Necessary:
• Starting & Finish Line (tape will work well)
• Time Keeping Device (stop watch)
• Tape Measure

Setup:
Place the start and finish lines exactly 10 feet apart, so they are parallel to each other; if you use tape, ensure that it won’t mark the track surface. The robot must start fully behind the starting line.

Background:
This challenge is a classic drivetrain acceleration optimization. If the robot is geared too fast, it will accelerate slowly which will cost it time. There is a balance between acceleration and top-speed which each designer must find.

Note, turning is NOT important for this challenge.

Hint:
Try adding more power to achieve faster acceleration even at a high top-speed.
Challenge #2 – Robot Figure-8

Description:
The challenge is to create a robot which can drive around a figure-8 shaped course in the least amount of time possible. Race multiple robots against each other, or play against the clock. Try doing multiple laps in the same race.

Equipment Necessary:
• Start / Finish Line (same line can be used for both)
• Two “Cones” that the robots must race around
• Time Keeping Device (stop watch)
• Tape Measure

Setup:
Place the two “cones” about 10-feet apart with a starting line running between them. Robots should follow a figure-8 path around the cones. The robot must start fully behind the start/finish line. During the race robots must not make contact with the cones.

Background:
Unlike the drag race, this course requires not only a robot with a good top-speed and acceleration but also good maneuverability.
Challenge #3 – Robot Tractor-Pull (Multiple Robots Required)

Description:
The challenge is to create a robot which can produce a large amount of forward force. Two robots will be connected together at the back by a piece of rope. Whichever robot pulls the other over a center line wins.

Equipment Necessary:
- Rope or Cord to Tie the Robots together (approximately 2 feet long)
- Center Line (tape will work well)

Setup:
Place the center line on the ground in the center of your playing surface. Tie two robots together such that they are centered over the center line. At the start of the pull, the rope between the robots should have no slack in it.

Background:
Pulling force is dependant on two factors, Traction & Torque; the robot must have a large amount of traction, but it also needs enough output torque to take advantage of that traction.

Hint:
There are two ways to increase traction, either increase the friction of the wheels, or increase the amount of weight resting on the wheels.

Also make sure that when the robots are pulling against each other, your robot remains stable and does not tip over. (Try attaching the rope below the rear axle, and putting as much weight in the front of the robot as possible.)
Challenge #4 – Robot Basketball

Description:
The challenge is to create a robot which can pick up tennis balls and deposit them in a bin (6-12” tall). Tennis balls will be scattered in an area around the bin. Race multiple robots against each other (each robot has its own bin), or play against the clock to see how fast you can pick up all the balls.

Equipment Necessary:
• Scoring Bin (between 6” and 12” tall)
  - A garbage can or cardboard box would work well.
• Time Keeping Device (stop watch)
• Tennis Balls (at least 3 per robot)

Setup:
Place the scoring bin in the center of your playing surface. Spread the tennis balls evenly around the bin on the floor. The robot must start touching the scoring bin.

Background:
Being fast at this challenge will primarily be determined by how quickly your robot can manipulate the tennis balls. Picking up the tennis balls quickly and accurately without a lot of driver adjustment will be the key to success. A simple reliable drivetrain is also important to the robot.

Hint:
Try picking up multiple tennis balls at the same time and scoring them all at once. This will make it so your robot doesn’t need to go back-and-forth to the goal as much, and will save time.
Challenge #5 – Ping-Pong-Pickup

Description:
The challenge is to create a robot which will pickup and hold 10 ping-pong balls as fast as possible. Race multiple robots against each other, or play against the clock. In head-to-head competition, limited ping-pong balls will result in robots competing to get as many as possible before their opponent grabs them.

Equipment Necessary:
• Ping Pong Balls (at least 10)
• Something to designate robot starting location
• Time Keeping Device (stop watch)

Setup:
Spread the ping pong balls evenly around the playing surface. If you are playing against the clock, ensure the balls are in the same location at the start of each trial. Place the starting location near the center of the playing area.

Background:
This challenge requires each robot to be designed with some method for picking up the ping-pong-balls and also some method for storing them. Integrating these two mechanisms together will result in a better overall system.

Hint:
Try using an accumulator which can pick up multiple ping-pong balls at the same time. Design a mechanism which is not reliant on precise positioning to pick up a ball. The faster the robot picks up the balls, the more successful it will be.
Challenge #6 – Stair Climber

Description:
The challenge is to create a robot which can climb a standard staircase as fast as possible.

Equipment Necessary:
Stairway
Time Keeping Device (stop watch)

Background:
Climbing stairs is not a difficult thing to do, but it is difficult to do it well. There are many ways to attempt this challenge. A smooth climbing method will result in a faster speed.

Hint:
A larger robot may have an easier time bridging the gap between steps; this would allow it to smoothly traverse up a staircase.
**Challenge #7 – Water Delivery**

**Description:**
The challenge is to create a robot which can effectively pick up a bottle of water and pour it in a cat or dog water bowl without spilling any.

**Equipment Necessary:**
- Bottle of Water
- Bowl (Dog or Cat Water Bowl)

**Background:**
Effectively manipulating objects is a common challenge for robots. Pouring water smoothly requires robot dexterity and good control.

**Hint:**
It is important for the robot to have a good grip on the bottle. The best robots will have grippers able to accommodate bottles of different sizes.

Think about how you would pour a bottle of water with your hand, and try to imitate this motion with your robot.
Challenge #8 – Rope Climber

Description:
The challenge is to create a robot which can climb up a rope without “winching” it in. For an extra challenge, the robot should be able to drive up to the rope, grab it, and then begin climbing.

Equipment Necessary:
• Length of Rope (try different ropes to see what the robot climbs best).

Background:
This challenge involves a mechanism which is used for robot mobility. By starting disconnected from the rope, things get even more complicated. Once the robot has a grip on the rope, it must be able to lift its own weight. It is important that the robot not lose its grip over time.

Hint:
Try to make the robot as light-weight as possible to make climbing easier.
**Challenge #9 – Chasm Crosser**

**Description:**
The challenge is to create a robot which can cross a “bottomless” pit. (Cross the pit without touching the floor below.) See how wide a chasm your robot can cross.

**Equipment Necessary:**
- Objects to form the edges of the Chasm (a pair of cardboard boxes work well)
- Ruler or Tape Measure

**Setup:**
Place the boxes a set distance apart; keep increasing this distance until your robot cannot successfully cross it.

**Background:**
Robot mobility systems must sometimes navigate across difficult terrain. Crossing a chasm or pit is an important ability for these systems to have. There are several options for crossing a chasm, the easiest of which is to just reach across the chasm.

**Hint:**
The location of the robot’s center of gravity (CG) will play an extremely important role in this challenge. Moving the CG across the chasm while maintaining a stable “footprint” on both sides will result in a successful crossing.
Challenge #10 – Door Opener

Description:
The challenge is to build a robot capable of opening a standard household door by turning the door knob. More advanced robots will be setup to open multiple types of doors.

Equipment Necessary:
• Find the door you will design your robot to open.

Background:
Any robot operating in the real world will need the ability to open doors. Developing a robot to complete this simple “human” task is challenging. Most door-knobs are not easy for a robot to manipulate, so this is a complex mechanical challenge. The height of the door-knob adds to the difficulty.

Hint:
Divide the challenge into two mechanisms: the elevation mechanism which will reach the knob, and the grabber mechanism which will manipulate the door-knob. If possible, use the actuator of the elevation mechanism to assist the knob turner.
Challenge #11 – Distance Toss

Description:
The challenge is to create a robot which can throw a ping-pong ball as far as possible. More advanced robots will be able to pickup ping-pong balls, or hold multiple ping-pong balls in a large hopper and feed them into the launch apparatus.

Equipment Necessary:
• Ping-Pong Ball(s)
• Tape Measure (to record throw distances)

Background:
This challenge is all about distance. A robot does not need a drivetrain to complete this challenge. There are multiple ways to launch a ball, search for different methods to accomplish the same task.

Hint:
Energy transfer is the key to launching the ball. Impart as much energy as possible to achieve great distance.
Challenge #12 – Egg Relay

Description:
The challenge is to build a robot which can pickup an egg, carry it 10 feet, and set it down safely. Multiple robots compete against each other or race against the clock to see who can carry a dozen eggs across the course the fastest.

Equipment Necessary:
• (12) Eggs per Robot (hardboiled may result in less cleanup)
• Starting & Finish Line (tape will work well)
• Time Keeping Device (stop watch)
• Tape Measure

Setup:
Setup the starting and finish lines 10-feet apart. Place the eggs before the starting line; put them in whatever configuration you want, as long as they are all behind the line.

Background:
Manipulating delicate cargo is a challenge for any robot. Robots must be designed to carefully pickup the eggs; this task requires a large amount of dexterity. The egg’s irregular shape adds to the difficulty.

Hint:
The best robots will be able to carry multiple eggs at the same time to decrease the number of “runs” they need to make.