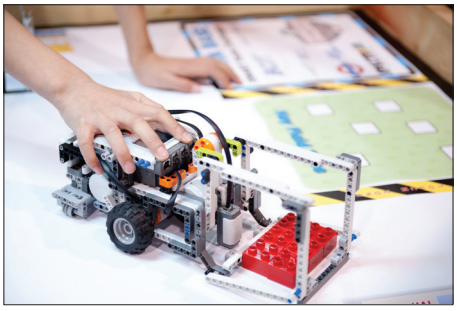
Introduction To Robotics

Unit Plan ~ Black Line Master






Effectively Using STEAM Education To Promote Project Based Learning In The 21st Century.

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BCIT™

Mitchell Odyssey Foundation

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Introduction to Robotics:

Unit Plan – Black Line Masters

The following lessons and instructional approach have been developed from our successful after-school programs. The unit plan provides educators with a clear instructional sequence needed to teach participants the core skills required to complete the GEARBOTS Training Challenge. GEARBOTS Educational Resources has developed double sided vinyl mats to complement and assist in the delivery of these lessons.

Items 1-8 should take approximately 10 sessions with the remaining classes working on the GEARBOTS Training Challenge using the CM001 Introductory Challenge Mat.

1. **Introduction to the unit (engineering process / iterative design)**
   - Build REM bots / kit orientation, computer orientation, and lab expectations (setup / cleanup procedures)

2. **Programming overview / orientation to the robotics platform**
   - Downloading firmware (if needed), programming environment, downloading a simple program, simple move blocks [straight and turn blocks using time]
      - Use TM001 Introductory Training Mat
      - Move Block Lesson (Tasks 1 to 9)
      - Summative Assessment: Square / Intersection Challenge

3. **Measured distance – converting distance (cm) into rotations or degree**
   - Introduction of Turning – Pivot [one wheel] and Point [two-wheel] turns
      - Use TM001 Introductory Training Mat
      - Use TM002 Grid Navigation / Maze Mat
      - Use VT005 Vortex / Buried Treasure Mat
      - Measured Distance Formula worksheet (Tasks A and B)
      - Navigational Protractor handout
      - Measured Distance and Degree Turns Lesson (Tasks 10 and 11)
      - Summative Assessment: Grid Navigation Challenge
      - Summative Assessment: Maze Challenge (Part A)
      - Summative Assessment: Vortex Challenge

4. **Wait for Touch (touch sensor)**
      - Use TM001 Introductory Training Mat
      - Wait for Blocks – Touch Sensor Lesson (Task 12 and 13)
      - Summative Assessment: VacuumBot Challenge

5. **Wait for Dark (light sensor)**
      - Use TM002 Grid Navigation / Maze Mat
      - Wait for Blocks – Light Sensor Lesson (Task 14 and 15)
      - Summative Assessment: Maze Challenge (Part B)

6. Loops and switches introduction / Following line

- Use the oval on TM001 Introductory Training Mat
- Use VT005 Vortex / Buried Treasure Mat
- Loops and Switches Lesson (Task 16)
- Review Challenge: 7 Block Review Program worksheet
- Summative Assessment: Line Following Challenge

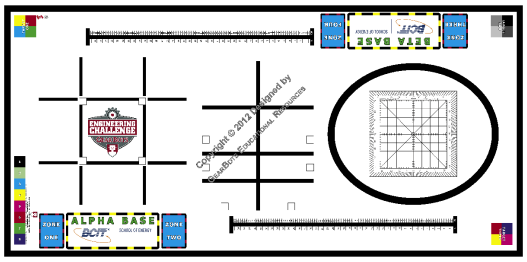
7. Wait for Near (ultra sonic sensor)

- Use TM002 Grid Navigation / Maze Mat (NOTE: must make light weight walls for the maze)
- Wait for Blocks – Ultra Sonic Sensor Lesson (Task 17)
- Summative Assessment: Walled Maze Challenge
- Summative Assessment: Obstacle Course Challenge
- Summative Assessment: Fruit Picker Challenge – picking a ball of a tower / drop in a basket

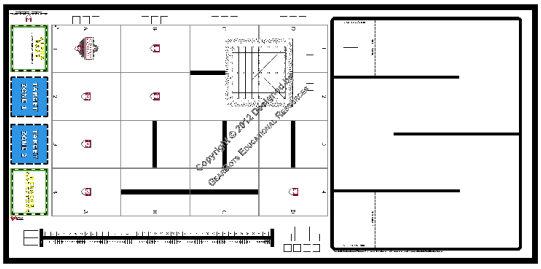
8. Training challenge – putting it all together

- Use CM001 Introductory Challenge Mat
- Application of skills: engineering process, working in teams, solving problems, creative thinking handouts
- Includes Mission Overview Handout, Engineering Logbook, Planning / Pseudo Code Booklet

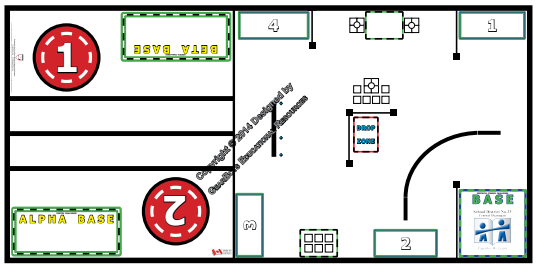
TM001 Introductory Training Mat



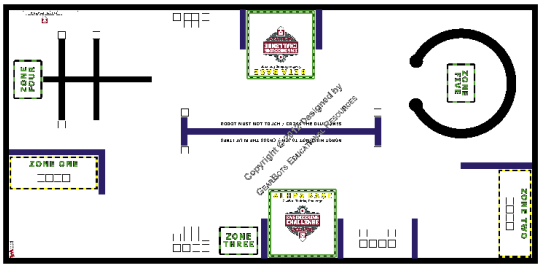
TM002 Grid Navigation / Maze Mat



VT005 Vortex / Obstacle Course Mat



CM001 Introductory Challenge Mat



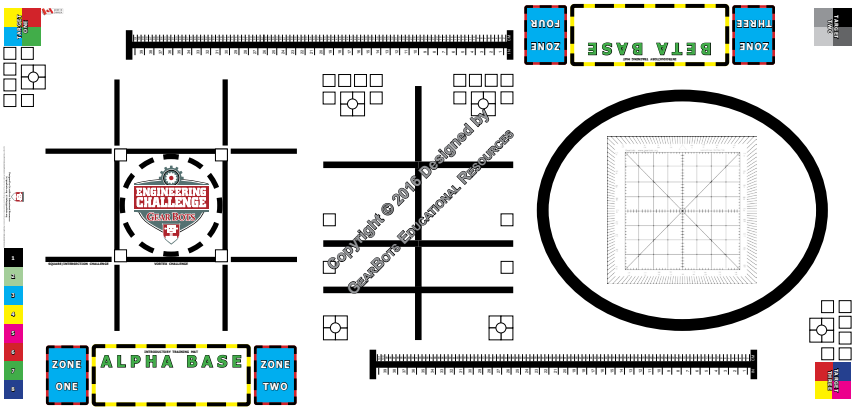
Introduction to Robotics: Core Instructional Designs

These four designs are an essential instructional tool for your robotics / coding unit.

Basic Training Mat

Item number: TM001
Mat One Side A with no border

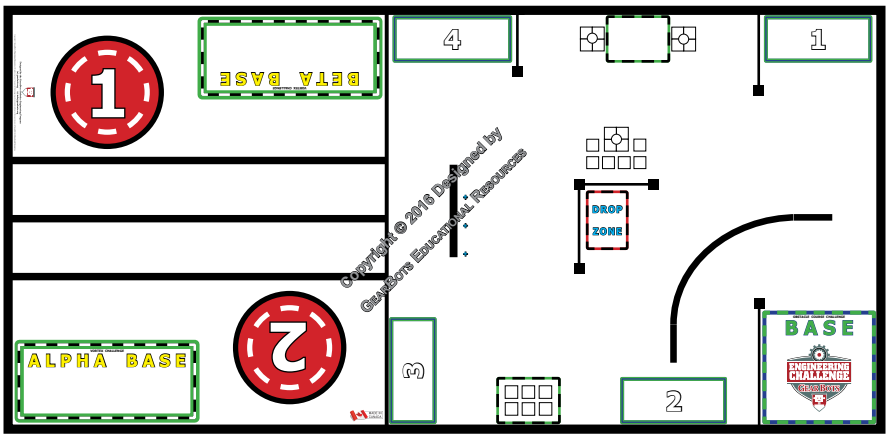
This is a great overall design to use in your robotics lab for testing your programming skills.



Vortex / Obstacle Course Mat

Item number: VT005
Mat One Side B with border

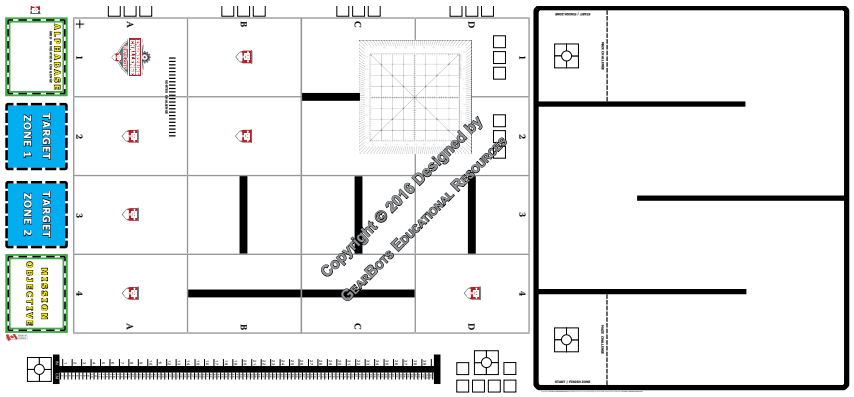
This design includes the Vortex Challenge and the summative challenges: Obstacle Course Challenge and the Fruit Picker Challenge.



Grid Navigation / Maze Mat

Item number: TM002
Mat Two Side A with no border

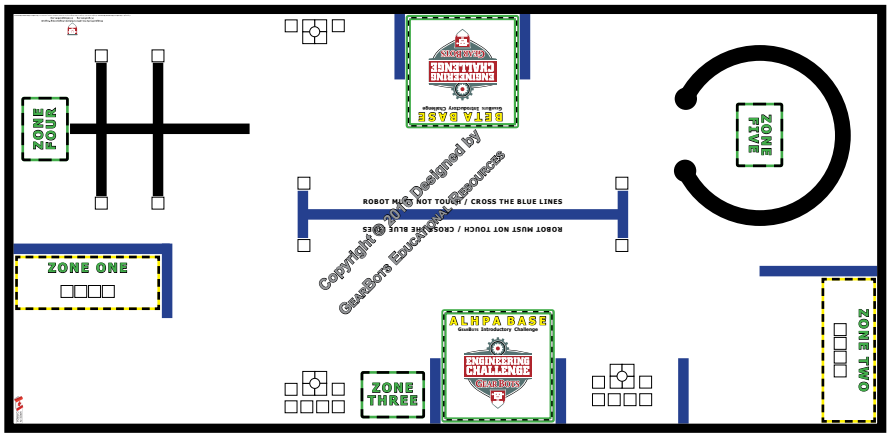
This design includes the Grid Navigation and Maze Challenges. They are great for practicing precise controls.

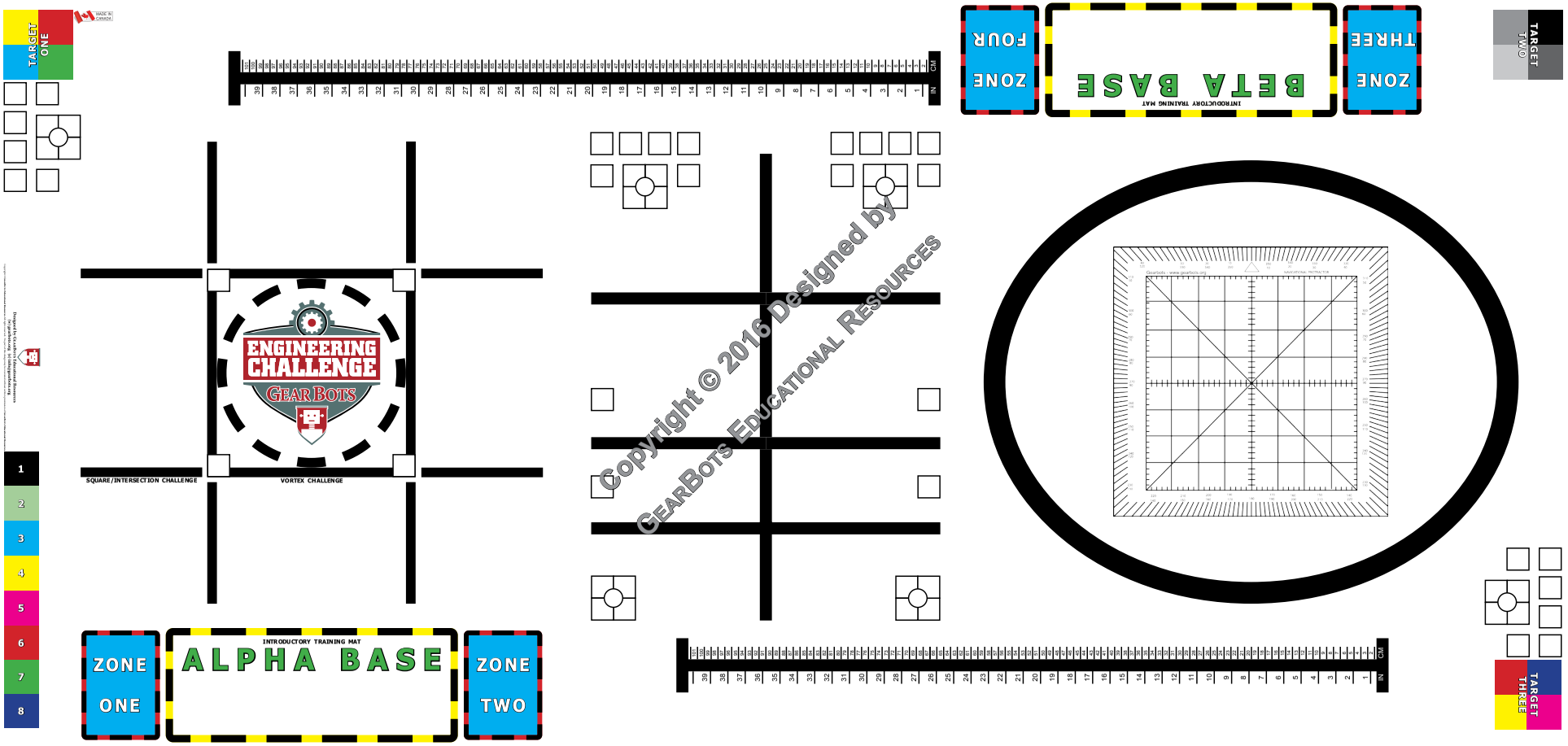


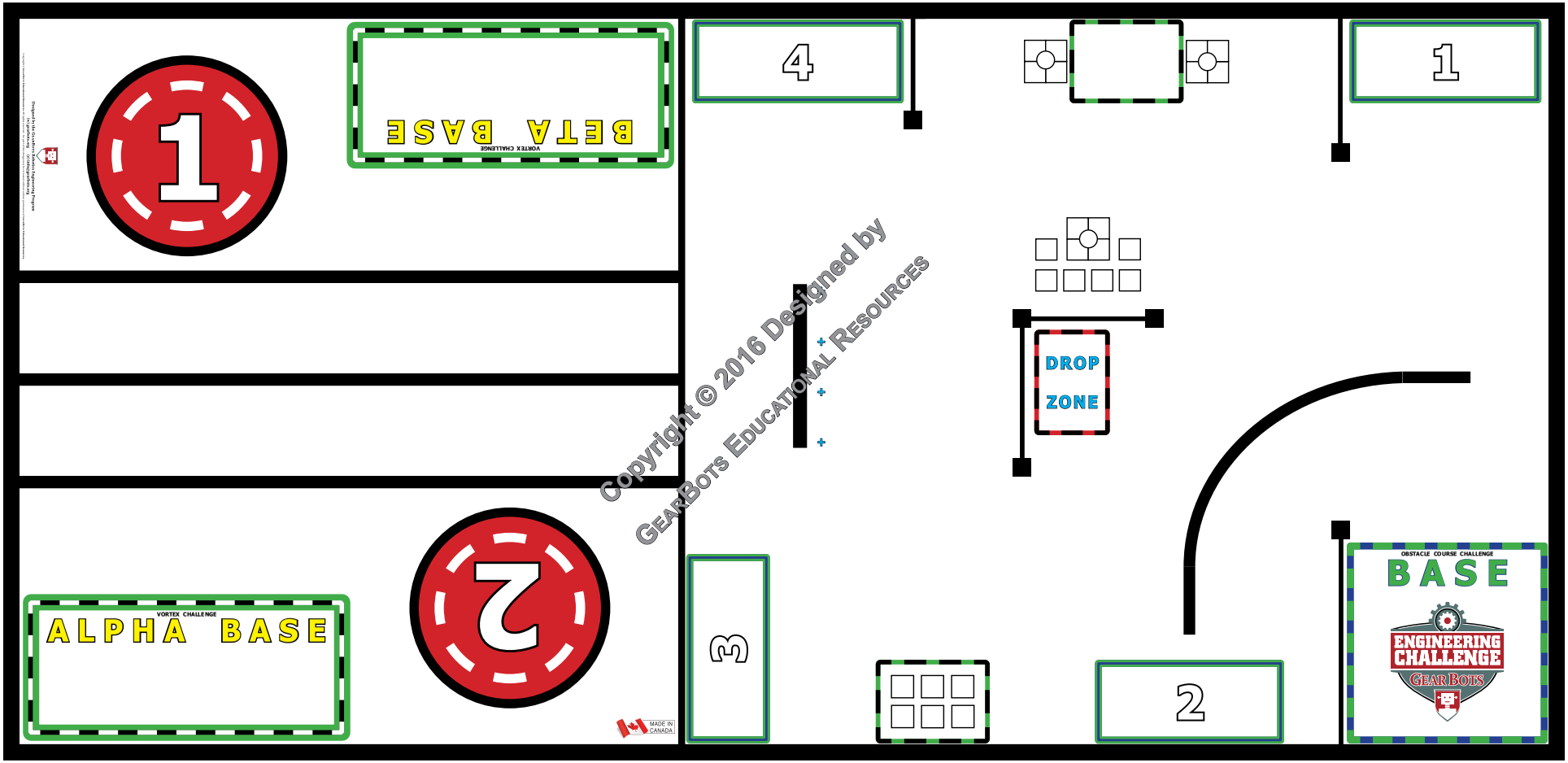
GearBots Challenge

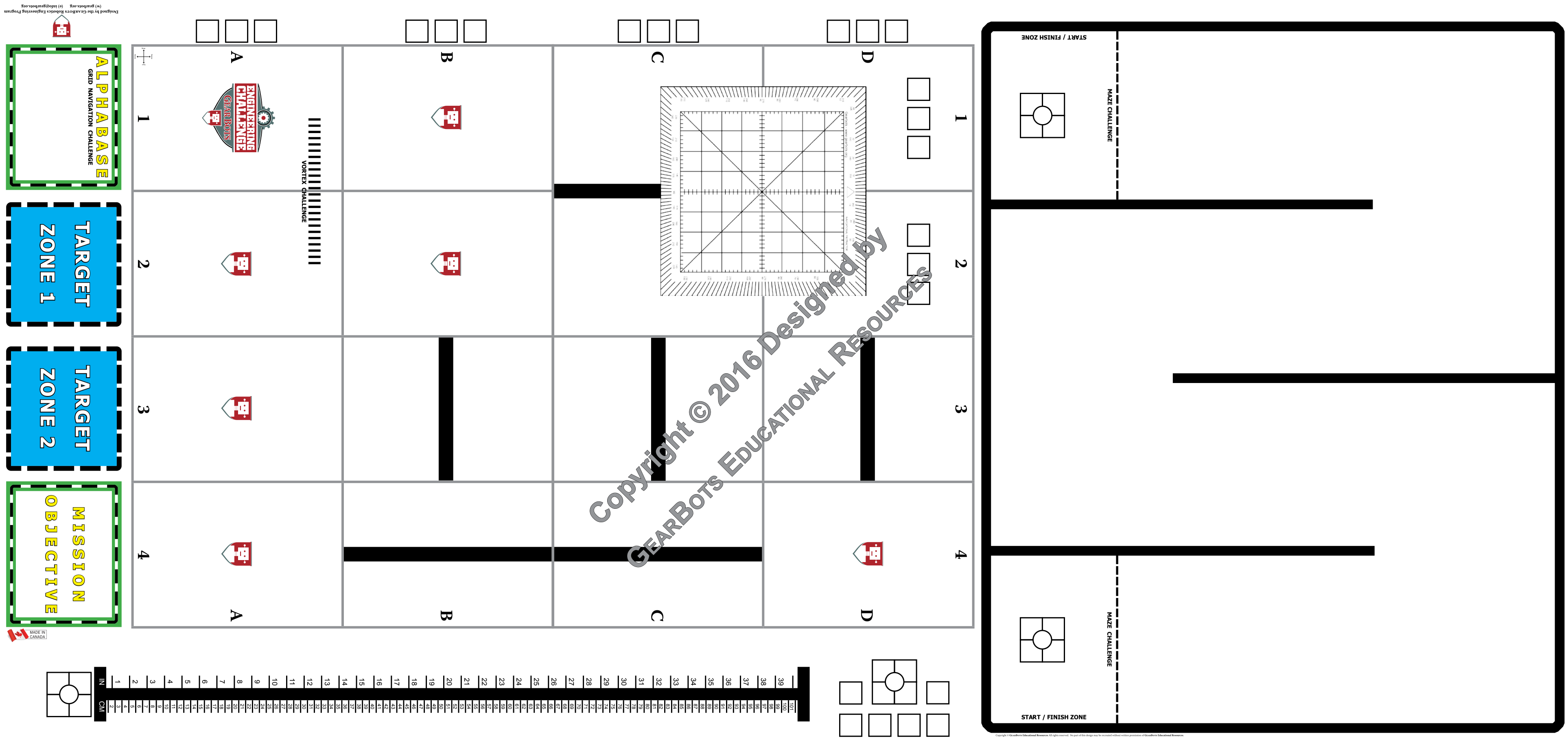
Item number: CM001
Mat Two Side B with border

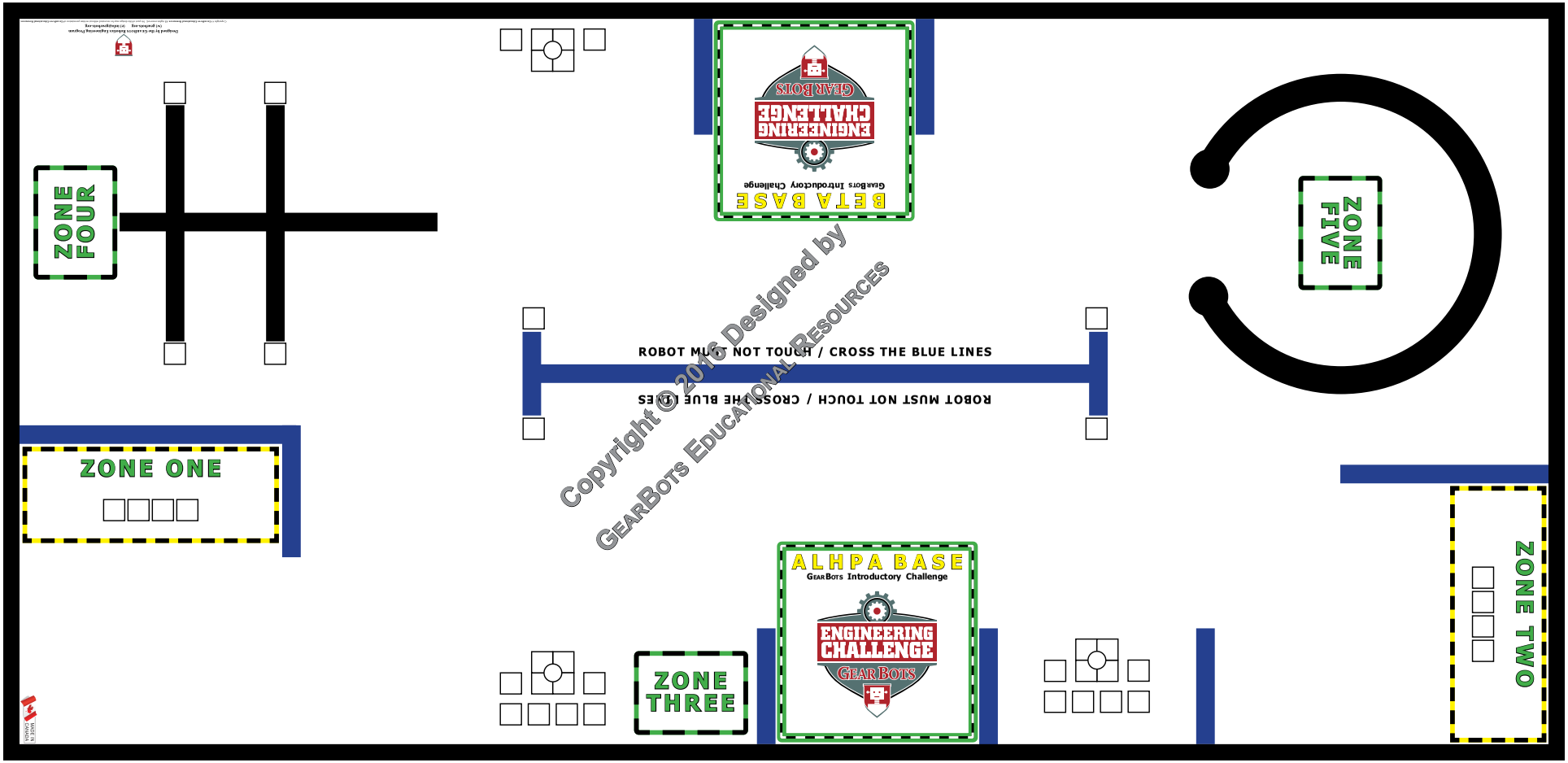
Once you have finished an introduction to robotics unit, challenge your class with this design. It is a great way for your students to show off their engineering / coding skills.











Name: _____ Date: _____

Introduction to Robotics

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A. Introduction to Move Blocks: - Use TM001 Introductory Training Mat

First, you will need to build the basic TestBot. Simply put… if you want your robot to move, you will have to build and program your robot using the motors provided in your kit. Programming motors will allow you to move your robot in the following ways:

1. Move forward or backwards for a specific duration
2. Efficiently and effectively complete turns (any specified degree or angle, pivot turn, point turn)
3. Change the speed (power output) and distance traveled (modifiers) of your motors
4. Complete a square (using loops)

Key concepts taught in the lesson:

- Graphic coding language, program blocks, move blocks, pivot and point turns, duration, ports, variables, iterative design, engineering method, programming - FLOW v1.0

1. Basic Movement: Must successfully complete each task before moving to the next one

- ☐ **TASK ONE:** Write, test and debug a program that allows your robot to travel forward for 2 seconds at 85% power and then coast to a stop. **Partner:** Change the amount of time.
- ☐ **TASK TWO:** Write, test and debug a program that allows your robot to travel forward for 3 rotations at 50% power, travel backwards for 400 degrees at 60% power, spin around once and then break to a stop. **Partner:** Change the speed (power level), direction, and the amount of time (fraction of a second - i.e. 1.5 seconds) and then stop.

CHECK-IN ➔

- ☐ **TASK THREE:** Write, test and debug a program that allows your robot to travel forward for 4 rotations at 35% power, make an approximate 90^0 turn, travel forward for 2.5 seconds and then coast to a stop. **Partner:** Change the duration of the move block to 1.4 rotations and make an approximate 180^0 turn.
- ☐ **TASK FOUR:** Write, test and debug a program that allows your robot to travel an unlimited amount of time forward.
  Questions: What did you observe? Did the program work?

2. Introduction to Loops:

- ☐ **TASK FIVE:** Write, test and debug a program that loops a 4-block program five times and then coast to a stop.
  Partner: Change the block order to change the robot's behaviour.

CHECK-IN ➔

- ☐ **TASK SIX:** Write, test and debug a program that loops a 2-block program two times then goes forward at 50% for 2.4 rotations and then break to a stop.
  Partner: Change the duration and power of the move blocks in the loop to change the robot's behaviour.

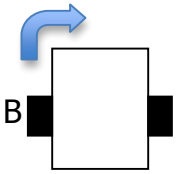
Name: _____ Date: _____

3. Introduction to Turning (Pivot and Points Turns):

1. Pivot = One wheel turns:

[example: Select a large motor block with a B port configuration]

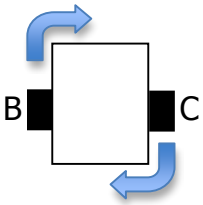
- ACTION: The robot will complete a pivot turn to the right



2. Point = Two wheel turns:

[example: Select a steering move block and move the steering bar all the way to the left]

- ACTION: The robot will complete a point turn to the left



☐ **TASK SEVEN:** Write, test and debug a program that that allows your robot to complete a one wheel turn (pivot turn) to the right for 2 rotations at 40% power. **Partner:** Change rotations and power to change the robot's behaviour.

☐ **TASK EIGHT:** Write, test and debug a program that allows your robot to complete a two wheel turn (point turn) to the left for 3 seconds at 83% power. **Partner:** Change amount of time and power to change the robot's behaviour.

CHECK-IN ➔ ☐ **TASK NINE:** Write, test and debug a program that allows your robot to travel at 50% power for 2.9 rotations forward, complete a right pivot turn for 1 second, travel backwards for 180 degrees, complete a two wheel turn (point turn) to the left for 1.5 rotations, and forward at 25% power for 1 rotation. **Partner:** Change the turning blocks in the task to change the robot's behaviour.

DISCUSSION QUESTION:

- Think about the characteristics/behaviours of both turns. Why and when would you use a point turn over a pivot turn?

4. ENGINEERING TEAM CHALLENGE: Use as a Summative Assessment

- Introduction to "Iterative Design" and the "Engineering Process" in the Engineering Methodology Booklet.
  - Now it is time to put your engineering skills and talents all together. Complete the assigned challenges below. Once done, check-in with your instructor.

☐ **Square / Intersection Challenge:** - Use Introductory Training Mat – TM001
Write, test and debug a program that completes the assigned challenge on the GEARBOTS Training Mat. You must alternate between pivot and point turns.
Partners: Each partner should take turns programming the solution to this challenge.

Square / Intersections Challenge

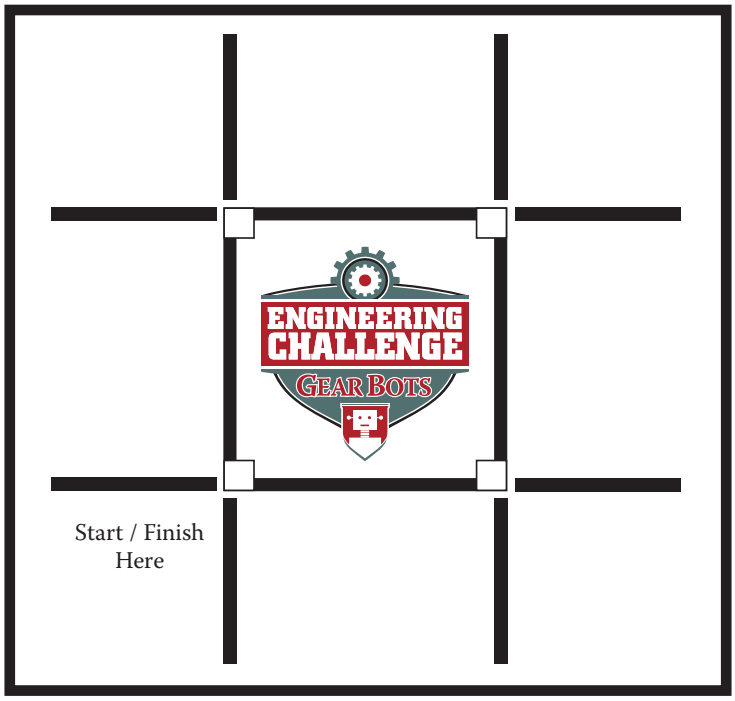
Use with the Introductory Training Mat - TM001

The objective of this introductory challenge is for your robot to move around the square without touching the square itself. Your robot should travel as close to the square as possible but remember no touching. If it does, you have to start over. You must complete the challenge without using the loops program feature. Beat the challenge by completing the task in less than 8 attempts.

Programming Review: Move blocks, pivot turn, point turn

Rules and Procedures:

1. Start your robot in the designated area
2. Program your robot to move around the square
3. Make approximately 90 degree turns at each corner
    - Alternate between pivot [one wheel] and point [two wheel] turns
4. Return to your original starting position



NOTE: DIAGRAM NOT TO SCALE

1. **Place robot in the start area**
2. **Drive forward and turn**
3. **Avoid touching the square**
4. **Return to the starting area**

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Name: _____ **Block:** _____ **Date:** _____

Introduction to Robotics: Measured Distance Formula

Updated: Mar.4.2014

Objective: Converting wheel circumference into rotations or degrees **Note: Based on standard CMU REMbot design / wheel configuration**

Key Terms:

- Formula: Mathematical statement, especially an equation, of a fact, rule, principle, or other logical relation.
- Diameter: A straight-line segment passing through the center of a figure, especially of a circle or sphere, and terminating at the periphery.
- Radius: A line segment that joins the center of a circle with any point on its circumference.
- Circumference: The boundary line of a circle.
- Pi: A transcendental number, approximately 3.14, represented by the symbol π, that expresses the ratio of the circumference to the diameter of a circle and appears as a constant in many mathematical expressions.

Measured Distance Formula:

Distance you want your robot to go in cm	÷	17.584cm	=	Wheel Rotations	X	360 degrees	=	
		Wheel diameter is approximate 5.6cm x 3.14 = 17.584cm		Could go with this or continue for greater accuracy		Degrees in a circle		Place this number in the correct move block

Try this first: 30cm ÷ 17.584cm = 1.7 rotations X 360 = 614^0 – place degrees into your move block - duration

TASK A: Program your robotic device to travel exactly 62cm forward at 40% power.

	÷		=		X	360^0	=	
		Wheel circumference		Rotations		Degrees in a circle		

TASK B: Program your robotic device to travel exactly 54cm forward at 70% power.

	÷		=		X	360^0	=	
		Wheel circumference		Rotations		Degrees in a circle		

Name: _____ **Block:** _____ **Date:** _____

Introduction to Robotics

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B. Introductions to Measured Distance and Degree Turns:

Now that you can make your TestBot move forwards, backwards and complete a point or pivot turn, it is time to learn how to make it travel a specific distance and turn a certain degree left or right.

1. Measured distance formula worksheet (C=17.584cm)
2. Calculating degree turns (view button and the 1:4 ratio) formula

1. Exact Distance Challenge: (use the main axle of the robot as a reference point)

TASK TEN: **Write calculations in the space provided below**

- ☐ 50 cm forward at 25% power
- ☐ 15 cm backward at 80% power
- ☐ 40 cm forward at 20% power
- ☐ 70 cm backward at 48% power

- ☐ Now, combine all four program blocks into one program. Each partner should program two of the blocks. Beat the challenge by having your robot stop on or near the 5 cm line (within 1 cm is considered accurate).

2. Programming Degree Turn:

- Using the 56mm (5.6cm tire) and a 1:4 ratio, the simplest ways to quickly determine degree turns are the following strategies:

1. One wheel turns - Pivot turn: take the degrees you want to turn and multiply it by 4
- Example: 90 degrees x 4 = 360 degrees (place into move block – duration + degrees)

2. Two wheel turns - Point turn: take the degrees you want to turn and multiply it by 2
- Example: 90 degrees x 2 = 180 degrees (place into move block – duration + degrees)

3. Degree Turn Challenges: REMEMBER: Make sure your back pivot wheel is properly aligned each time.

A. Standing Still – stationary position using the navigational protractor

TASK ELEVEN:	**Write calculations in the space provided below**
☐ 90^0 to the left at 50% power - point turn (two wheel)	
☐ 180^0 to the right at 40% power - pivot turn (one wheel)	
☐ 270^0 to the left at 30% power - point turn (two wheel)	
☐ 720^0 to the right at 20% power - pivot turn (one wheel)	
☐ 45^0 to the left at 20% power - point turn (two wheel)	
☐ 360 to the right at 35% power - pivot turn (one wheel)	
☐ 315^0 to the left at 95% power - point turn (two wheel)	
☐ 135^0 to the right at 44% power - pivot turn (one wheel)	

DISCUSSION QUESTION:

- Was your robot's behaviour the same once you introduced movement into your program? Observe and compare the different behaviours using the 90 degree turn (stationary and adding movement).

OTHER STRATEGY:

- Try using the view button feature on your NXT/EV3 Brick to help figure out add degree turns.

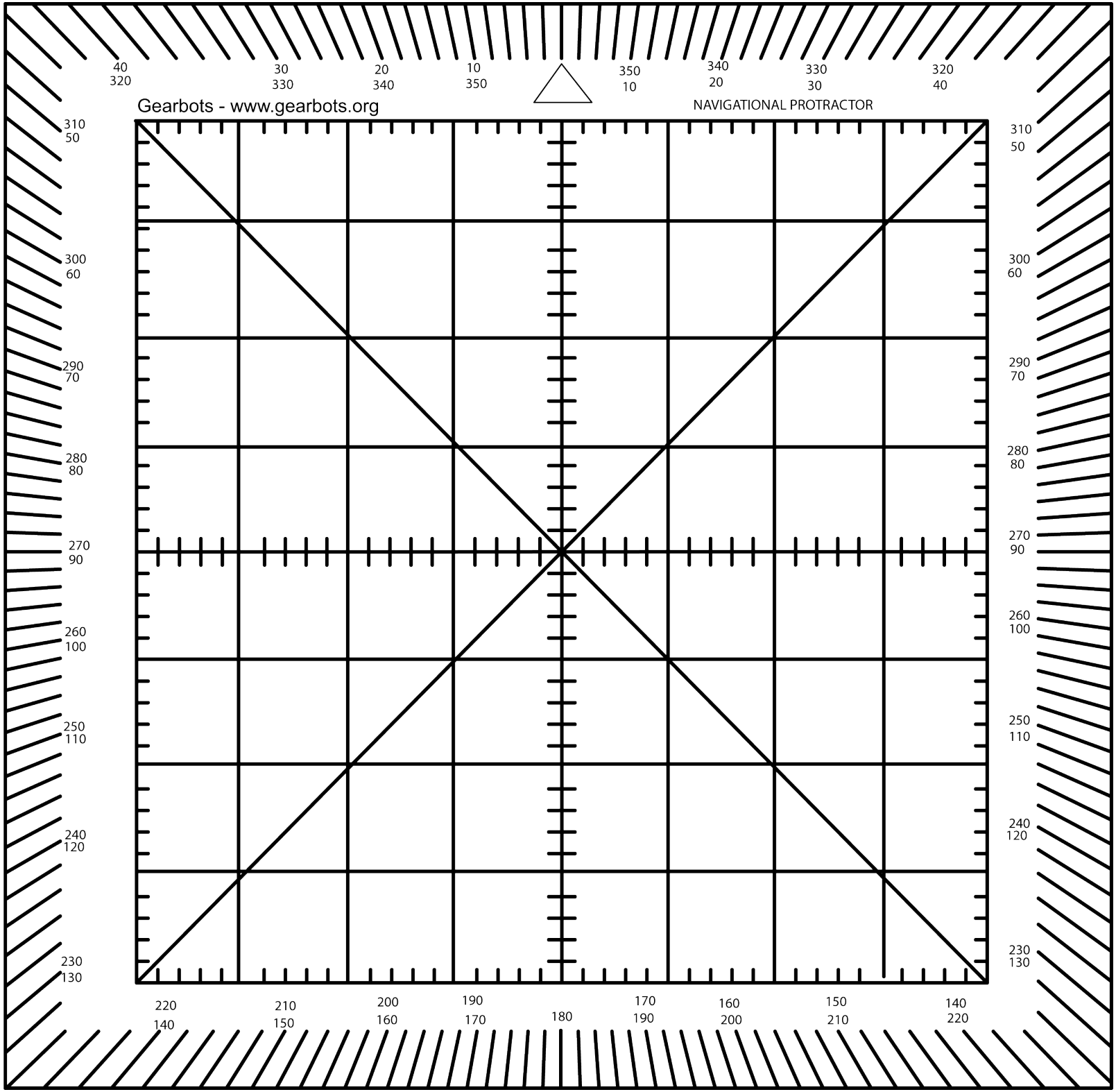
4. ENGINEERING TEAM CHALLENGES: Use as a Summative Assessment

- Now it is time to put your engineering skills and talents all together. Complete the assigned challenges below. Once done, make sure to show your teacher.

☐ **Grid Navigation Challenge** – see handout for instructions.

☐ **Maze Challenge (Part A)** – see handout for instructions

☐ **Vortex Challenge** – see handout for instructions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NAVIGATIONAL PROTRACTOR
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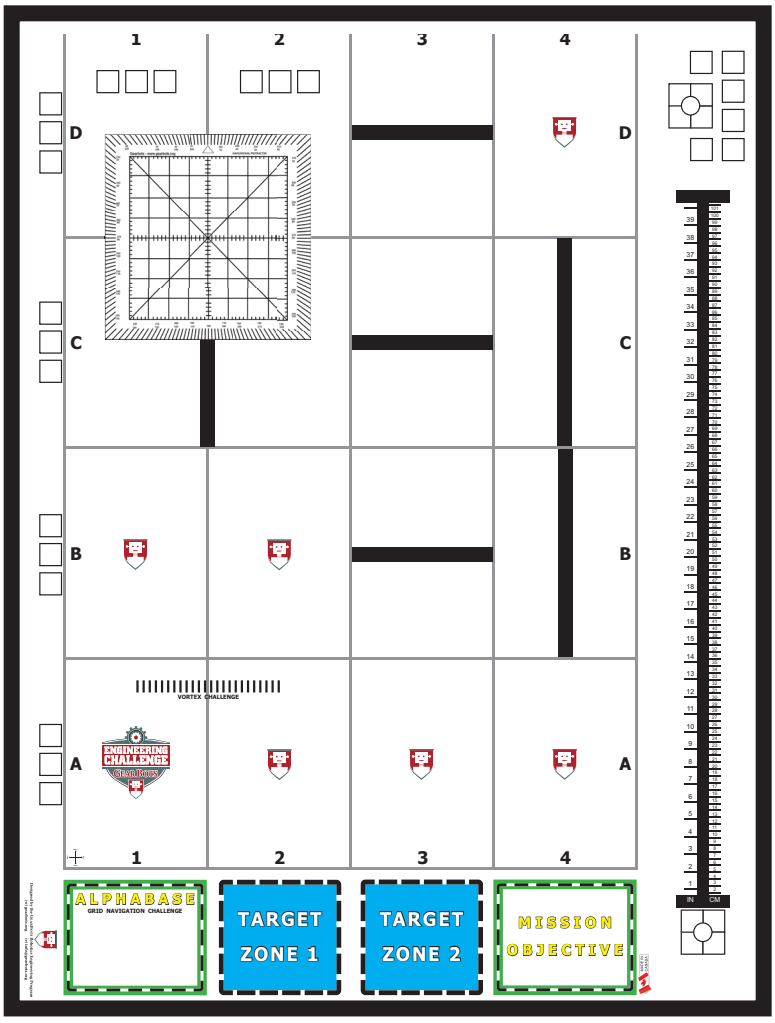
140 220

Grid Navigation Point Challenge

Now it is time to practice your measured distance and degree turn programming skills. Using a tape measure, record the measurements, convert cm into degrees and program your robotic device to navigate successfully through the course set by your instructor.

Rules and Procedures

1. Start with wheels inside the Base.
2. The center of your robotic device must pass over each of the GearBots logos.
   Remember to build your program one step at time (test each program block first).
3. Your robotic device must return to the Mission Objective zone with all wheels inside the box.
   Challenge Activity: Once you get to the Mission Objective zone, turn around and retrace your steps to return back to the starting box.
4. If you touch your robotic device, you are disqualified.
5. Beat the challenge by completing the challenge in under 20 seconds.



Note: Diagram Not to scale

1. **Place robot inside the Base - wheels inside**
2. **Travel to the assigned grid points**
3. **Execute the appropriate degree turns**
4. **Return to the Mission Objective zone - wheels inside**

Extension Activity:

5. **From the Base, collect an object in one of the designated areas. Move the object to one of the it Target Zones. Return to the Mission Objective zone - wheels inside.**

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Maze Challenges

Use with the Grid Navigation / Maze Mat - TM002

This challenge is an opportunity to walk through the basic steps involved in a challenge. You must work together in your teams to solve the two maze challenges as accurately as you can. Remember to build your program one step at a time (baby steps). You **MUST** finish the first challenge before moving onto the next Maze Challenge.

A. Measured Distance / Degree Turns Maze Challenge (servo motor):

Review: Measured distance, degree turns

Objective: From one of the starting areas, program your robotic device to navigate through the Maze without any part of your robot touching the black lines.

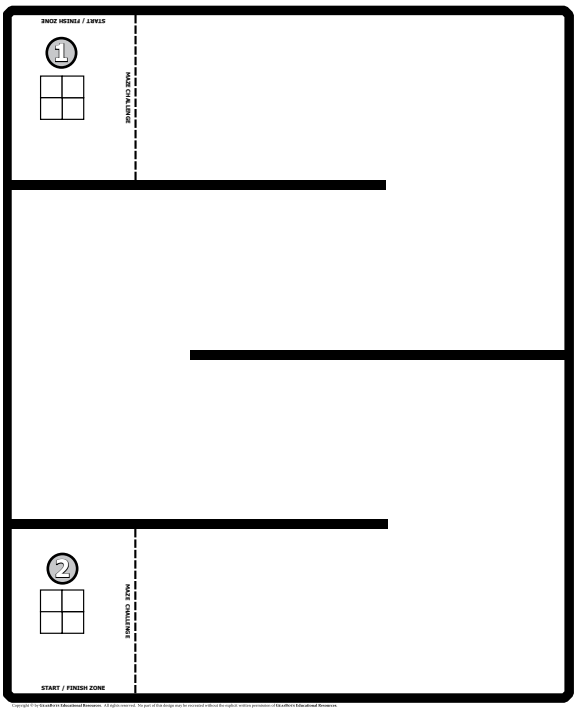
Challenge Activity: Complete the Maze in under 20 seconds.

B. Light Sensor (wait for dark) Degree Turns Maze Challenge:

Review: Wait for dark, determining thresholds, degree turns

Objective: From one of the starting areas, program your robotic device to navigate through the Maze without any part of your robot touching the black lines using your light sensor.

Challenge Activity: Complete the Maze in under 20 seconds.



1 **Starting area**

2 **Finishing area**

Note: Diagram Not To Scale

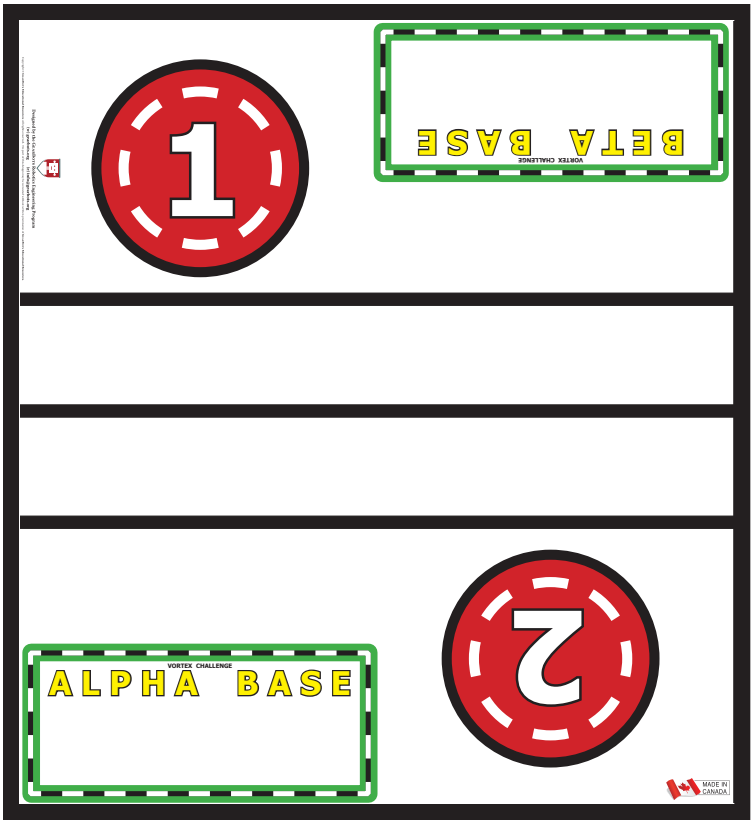
Vortex Challenge

Use with the Vortex Challenge / Obstacle Course Challenge Mat - VT005

Around and around you go! Where you stop, nobody knows. Your robotic device must travel to the circle, spin three full times around and return to the base as quickly as possible. In this challenge, practice moving and turning using rotations, degrees, pivot turns, and point turns.

Rules and Procedures:

1. Start with all wheels in the base.
2. Your robotic device must travel forward, stop inside the circle, and turn at least three full times around. The robot cannot leave the circle while spinning, or it will be disqualified.
3. Your robotic device must return to its starting location (base) when it is done.
   Challenge Activity: Try both a pivot turn (one wheel) and a point turn (two wheel).
4. Beat the challenge by completing the drill in under 15 seconds.



NOTE: DIAGRAM NOT TO SCALE

1. **Start in the Base**
   - Whole robot must be inside the base
2. **Travel to the circle**
   - Perform 3 full spins inside the circle
3. **Return back to Base**

Name: _____ Date: _____

Introduction to Robotics

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C. Introduction to Wait For Blocks:

This block lets your robot sense its environment for a certain condition before it continues. Use the slider or type in a value to set a trigger point so that the program continues when the sensor values are below or above it.

Key concepts taught in the lesson:

- Touch, light / reflection of light, electromagnetic spectrum, measurement, calculating thresholds, switches, loops, time, wait for condition, if then statements

Building Instructions:

You will need to add the light and touch sensor attachment to the front of your REM TestBot.

- See your construction manual for the appropriate instructions to build the light sensor, touch sensor, and ultra sonic sensor attachments.

1. What Is A Touch Sensor: Contact Switch

When the Touch Sensor is pressed, it closes an electrical circuit, allowing current to flow. If the Touch Sensor is released, the circuit is broken and no current flows. The flow (or lack) of current is detected by the NXT, allowing it to determine whether the Touch Sensor is pressed.

☐ **TASK TWELVE:** Write, debug and test a program that allows your robot to travel forward at 20% power until it touches an object (your hand or the side of the testing board) and stops.

Partner: Make it play a sound when it touches an object.

☐ **TASK THIRTEEN:** Write, debug and test a program that allows your robot to travel forward at 25% power until it touches an object (your hand or the side of the testing board) and backs up at 65% power for one rotation, turns approximately 90 degrees and then stops.

Partner: Change power level and program the robot to turn 180 degrees. Loop the program 4 times.

2. ENGINEERING TEAM CHALLENGE: Use as a Summative Assessment

- Now it is time to put your engineering skills and talents all together. Complete the assigned challenge below. Once done, make sure to show your teacher.

☐ **VacuumBot Challenge** – see handout for instructions

VacuumBot Challenge

Use with the Introductory Training Mat - TM001

Move Unit Touch Challenge:

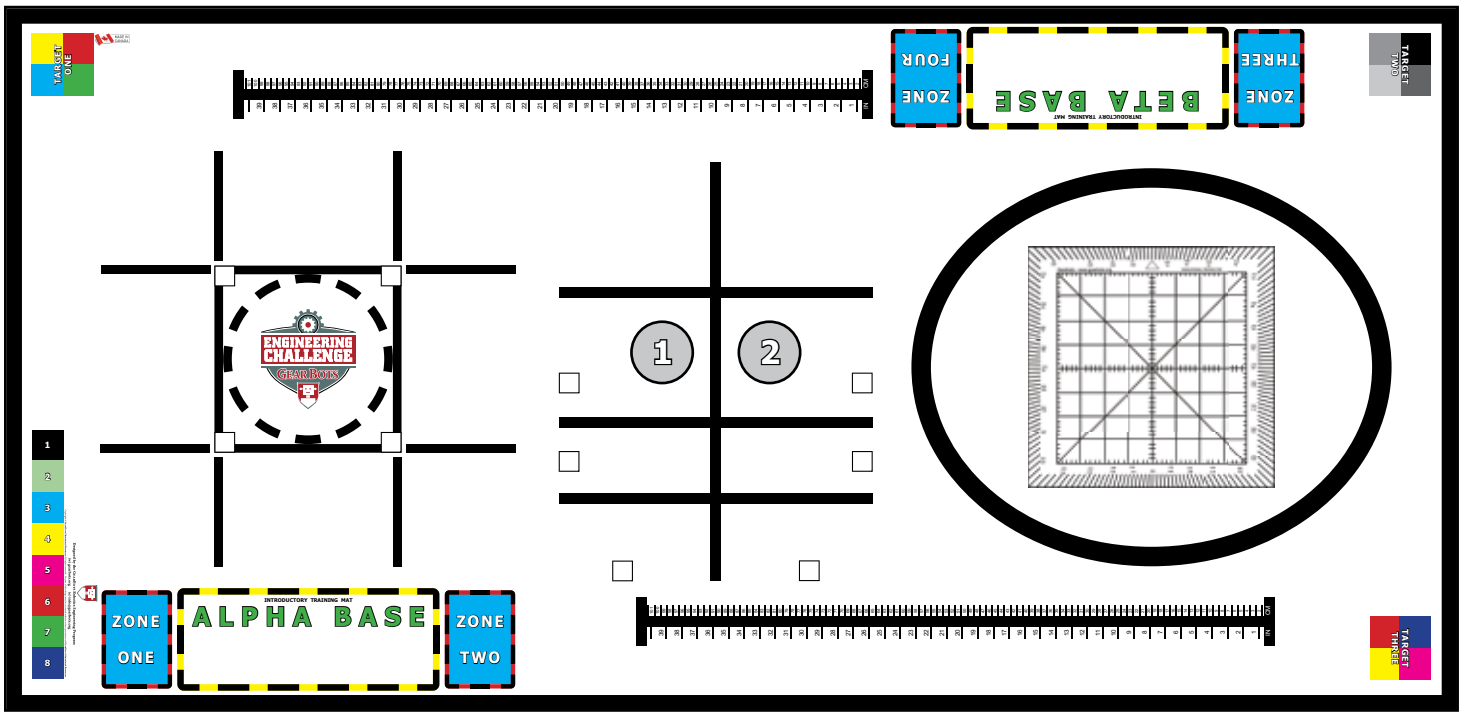
In this challenge, you must program your VacuumBot device to touch all four walls of the testing board.

Rules and Procedures:

1. Start the robot in the middle of the testing board.
2. Keep the board free of obstacles.
3. Position the robot any way you wish at the start.
4. Run your program.
5. Your robot must make physical contact with all four walls of the testing board during a single run (without getting stuck) to complete the challenge.

1 Starting area

2 Finishing area



NOTE: DIAGRAM NOT TO SCALE

(e) info@gearbots.org (w) gearbots.org

Name: _____ Date: _____

Introduction to Robotics

GEARBOTS Educational Resources Promoting Science, Technology, Engineering, Arts and Math (STEAM Education)

D. What Is A Light Sensor: Active Light Sensing

The red LED bulb on the NXT light sensor emits light that reflects off surfaces. The clear phototransistor bulb receives this light and uses it to control an electrical signal that is sent back to the NXT. The more light that the sensor receives, the higher the reading the NXT will display. "Brighter" surfaces generally reflect more light, and therefore give higher readings.

1. What is a "Threshold" and how do you calculate it?

Using the view button feature, locate the correct sensor and port. Place the sensor over the light surface and record the number. Place the sensor over the dark surface and record the number. Complete the following formula:

Light surface number		Dark surface number				
	+		÷ 2 =			

2. Greater Than vs. Less Than Symbols:

In mathematics, an **inequality** is a statement of how the size or order of two objects are similar or different.

< If one value is smaller than another, we use a "less than" sign. example: 3 < 5

> If one value is bigger than another, we use a "greater than" sign. example: 9 > 6

3. Wait For Dark Exercises:

- ☐ **TASK FOURTEEN:** Write, debug and test a program that allows your robot to travel forward at 45% power until it sees a black line and then stops.
  Partner: Add a reverse block at 75% power to return the robot to its original starting position.
- ☐ **TASK FIFTEEN:** Write, debug and test a program that allows your robot to travel forward at 20% power until it sees a black line, stop, complete a 180 degree Point Turn at 25% power and return to its original starting position at 60% power.
  Partner: Change to a pivot turn and change the power settings of the move blocks.

Name: _____ Date: _____

4. Following A Dark Line Exercise:

- Program Blocks: Introduction to Switch Blocks and a review Loop Blocks

☐ **TASK SIXTEEN:** Write, debug and test a switch program that allows your robot to follow a black line at 50% power for 10 seconds.
Partner: Change the program so your robot follows the other side of the line (robot must travel in the same direction).

5. ENGINEERING TEAM CHALLENGES: Use for Summative Assessments

- Now it is time to put your engineering skills and talents all together. Complete the assigned challenge below. Once done, make sure to show your teacher.

☐ **Maze Challenge (Part B)** – see handout for instructions

☐ **Review Task / 7 Block Program** – see handout for instructions

Maze Challenges

Use with the Grid Navigation / Maze Mat - TM002

This challenge is an opportunity to walk through the basic steps involved in a challenge. You must work together in your teams to solve the two maze challenges as accurately as you can. Remember to build your program one step at a time (baby steps). You **MUST** finish the first challenge before moving onto the next Maze Challenge.

A. Measured Distance / Degree Turns Maze Challenge (servo motor):

Review: Measured distance, degree turns

Objective: From one of the starting areas, program your robotic device to navigate through the Maze without any part of your robot touching the black lines.

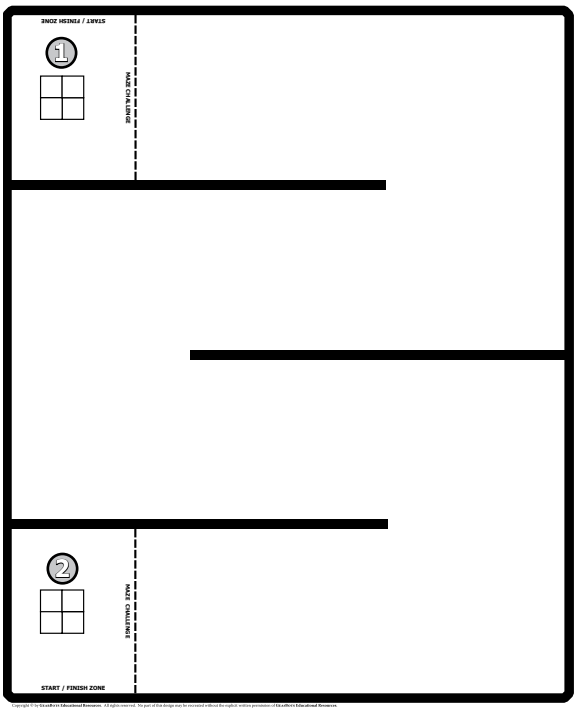
Challenge Activity: Complete the Maze in under 20 seconds.

B. Light Sensor (wait for dark) Degree Turns Maze Challenge:

Review: Wait for dark, determining thresholds, degree turns

Objective: From one of the starting areas, program your robotic device to navigate through the Maze without any part of your robot touching the black lines using your light sensor.

Challenge Activity: Complete the Maze in under 20 seconds.



1 **Starting area**

2 **Finishing area**

Note: Diagram Not To Scale

Name: _____ Date: _____

Introduction to Robotics

GEARBOTS Educational Resources Promoting Science, Technology, Engineering, Arts and Math (STEAM Education)

Review: 7-Step Program

Use with the Introductory Training Mat – TM001

This review activity is designed to test the following key skills: moving forward / back, converting cm into degrees, degree turns, wait for touch, dark and near. Remember to save your program often. Save your program in stages – different file names just in case your program becomes corrupted. Remember to follow the "Iterative Design Process".

- ☐ **STEP ONE:** From one of the bases, move unlimited at 45% until touch and stop
- ☐ **STEP TWO:** Back up 30 cm at 50% power
- ☐ **STEP THREE:** Make a right turn (1 wheel 90 degree turn) into open space
- ☐ **STEP FOUR:** Go forward at 25% power and stop at a dark line (find a suitable one)
- ☐ **STEP FIVE:** Make a 360 degree 2 wheel turn to the right at 65% power
- ☐ **STEP SIX:** From this location, search for a line to follow – follow for approx. 5 seconds
- ☐ **STEP SEVEN:** Return to base – stop with both wheel inside the base

Pseudocode Area: MUST show your calculations in space provided below.

Name: _____ Date: _____

Introduction to Robotics

GEARBOTS Educational Resources Promoting Science, Technology, Engineering, Arts and Math (STEAM Education)

E. What Is An Ultra Sonic Sensor: Sonar Ranger Finding

The Ultrasonic Sensor uses the speed at which sound waves travel to measure the distance to an object. The sensor has two openings on its front; one opening emits ultrasonic waves, while the other receives them. The Ultrasonic Sensor measures distance by timing how long it takes for an ultrasonic wave sent out by the emitter to bounce off an object and come back to the receiver.

1. Move Until Near Exercise:

- Program Blocks: Review Switches and Loops

☐ **TASK SEVENTEEN:** Write, debug and test a program that allows your robot to travel towards an object and stop 10cm away from it. Remember, it must not hit the object.
Partner: Change the program so your robot backs away from the object, turns 90 degrees and loops the program four times.

2. ENGINEERING TEAM CHALLENGE: Use as a Summative Assessment

- Now it is time to put your engineering skills and talents all together. Complete the assigned challenge below. Once done, make sure to show your teacher.

☐ **Move Unit Near - Walled Maze Challenge** – see handout for instructions

☐ **Obstacle Course Challenge** – see handout for instructions

EXTRA CHALLENGE:

☐ **Fruit Picker Challenge** – see handout for instructions
- Teams must build a grabber device using extra motor (port A)

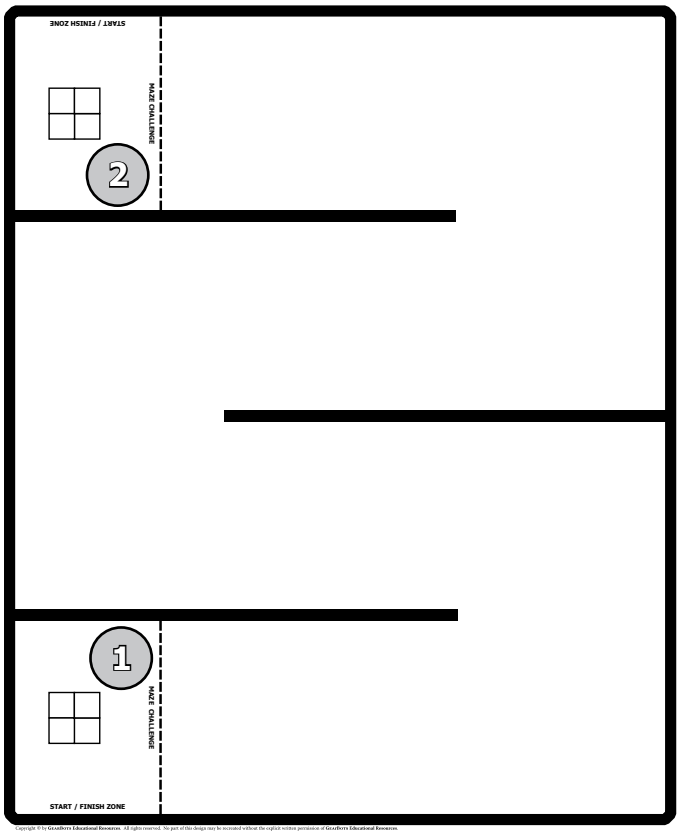
Move Unit Near: Walled Maze Challenge

Use the Grid Navigation / Maze Challenge Mat - TM002

This challenge features a slightly varied layout using the standing wall placed on the thin black lines. The robot must begin at the starting point (#1 below), and get to the goal (#2) using moving and turning behaviours. However, the dimensions of the hallway may change, and your robot must use its sensors to help navigate the maze!

Rules and Procedure

1. Start the robot inside the Starting Area (marker #1)
2. The robot must stop in the Goal Area (marker #2).
3. All walls should be constructed to be solid and elevated. Use lightweight materials so they do not mark the mat.
4. Wall lengths may vary, but turns will always remain the same.
5. Reach the goal without any touches to beat the challenge.



1 Starting Area

2 Finishing Area

NOTE: DIAGRAM NOT TO SCALE

Obstacle Course Challenge

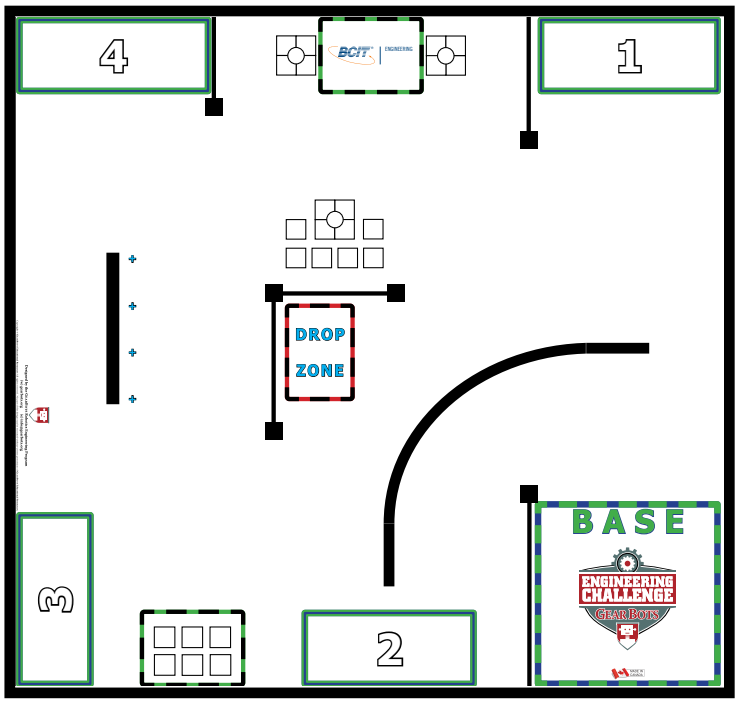
This challenge features a sequence of tasks that the robot must perform in order to get to the end of the course. The robot must move from a base, touch the edge of the board/object, follow a line, avoid an object, get to a safe area, then move forward, follow another line before coming to a complete stop in zone 4.
A combination of both previously-learned and new behaviours will be needed to accomplish these tasks.
Remember to use the Iterative Design Process when solving this challenge.

Rules and Procedures:

- Complete all numbered steps in a single run (program) to beat the challenge.

Robot Configuration: Smart motors, colour sensor, touch sensor, ultrasonic sensor

1. Start with the robot in the Base.
2. The robot must travel towards Zone 1 and touch the side board.
3. The robot must backup and turn to follow the line towards Zone 2.
4. Once the robot approaches the end of the line, use the ultra sonic sensor to avoid touching the wall or object in Zone 2.
5. At Zone 2, the robot must complete a one wheeled turn and travel towards Zone 3. It cannot touch the side board.
6. The robot must enter Zone 3, complete a two wheeled turn and wait 2 seconds before continuing towards Zone 4.
7. The robot must follow the line between Zones 3 and Zones 4 while heading for Zone 4.
8. The robot must finish with two wheels inside Zone 4.



NOTE: DIAGRAM NOT TO SCALE

1. **Touch the side board**
2. **Follow the line**
3. **Avoid touching side board**
4. **Rest in the parking area**
5. **Follow the line**
6. **Park in the target zone**

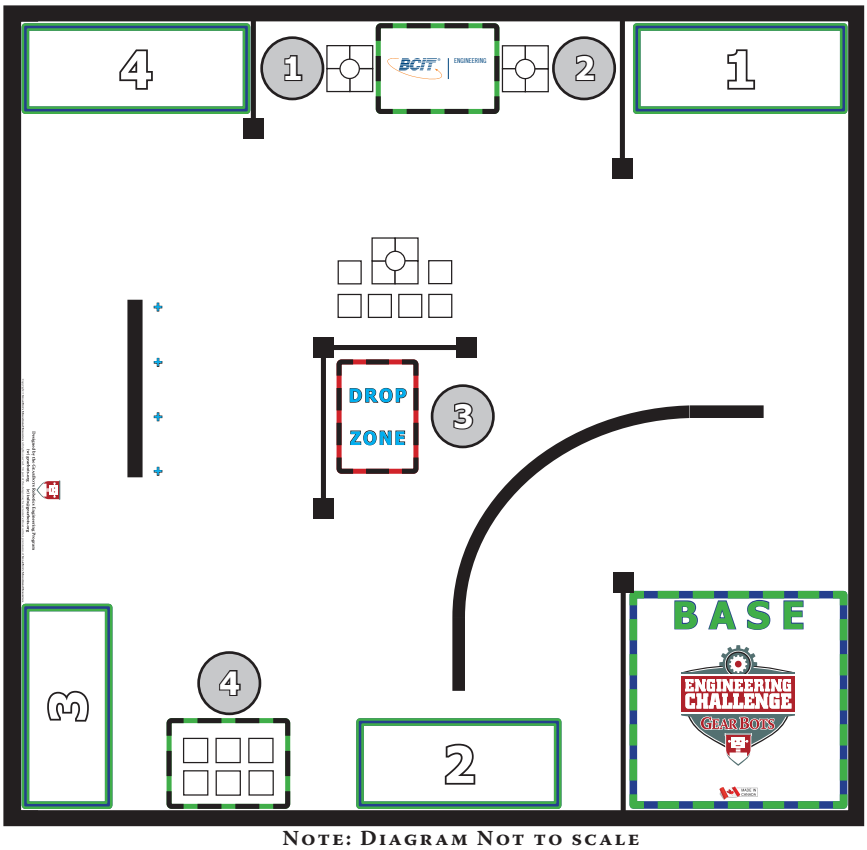
Fruit Picker Challenge

NOTE: Use VT005 - Vortex / Obstacle Course Challenge Mat

In this challenge, using two separate programs and missions, you must pick two pieces of simulated fruit and deliver them safely to their assigned DROP ZONE basket

Rules and Procedures:

1. Start the robot inside the BASE (see below).
2. The robot must transport the two pieces of fruit from the trees to the target zone
   - You may not touch the fruit by hand once the round has started
   - You will use two separate programs / missions to complete this challenge
   - The fruit must land and come to rest inside the basket to count
3. Beat the challenge by successfully picking and delivering both pieces of fruit to the two assigned DROP ZONES



NOTE: DIAGRAM NOT TO SCALE

Start in the BASE

1 2 **Travel to the trees**
- Select the fruit assigned fruit
- Two separate missions

Example:
A. Fruit One to DROP ZONE 3
B. Fruit Two to DROP ZONE 4

3 4 **Deliver the fruit to the assigned DROP ZONE**
- Drop in the assigned basket

GearBots Introductory Challenge

Use with the Introductory Challenge Mat - CM001

For the **GearBots Introductory Challenge**, your goal is to finish all the assigned missions in the time given. You can touch your robot only when it is crosses into the BASE. You cannot combine missions. You can modify your robot between missions. Missions can be done in any order you want. Remember to use Iterative Design when solving this challenge.

1. Missions from the APLHA BASE:

- ☐ **ALPHA BASE Primary Mission A: Travel to the Broken Circle**
  Your robotic device must travel from the **ALPHA BASE** to **BROKEN CIRCLE ZONE**, follow the black line using a light sensor program around the **BROKEN CIRCLE ZONE** (as much of the line as you can), and return back to the **ALPHA BASE**.

- ☐ **ALPHA BASE Primary Mission B: Line Tree**
  Your robotic device must travel from the **ALPHA BASE** to the **LINE TREE ZONE**, cross over the first branch and turn at the second / top branch. Use a light sensor to follow the top line and return back to the **ALPHA BASE**.

Extension Mission: Can only attempt this Extension Mission once **ALL** Primary Missions from the ALPHA BASE have been successfully completed/evaluated by the judges.

- ☐ **ALPHA BASE Extension Mission C: Picking Up Ball in Zone One**
  Your robotic device must travel from the **ALPHA BASE**, pick up the **BLUE/RED** ball from one of the designated spots from the **ZONE ONE TOWER** located in **ZONE ONE**, deliver/drop the **BLUE/RED** ball into the **CONTAINER** located in **ZONE THREE**, and return back to the **ALPHA BASE**.

2. Missions from the DELTA BASE:

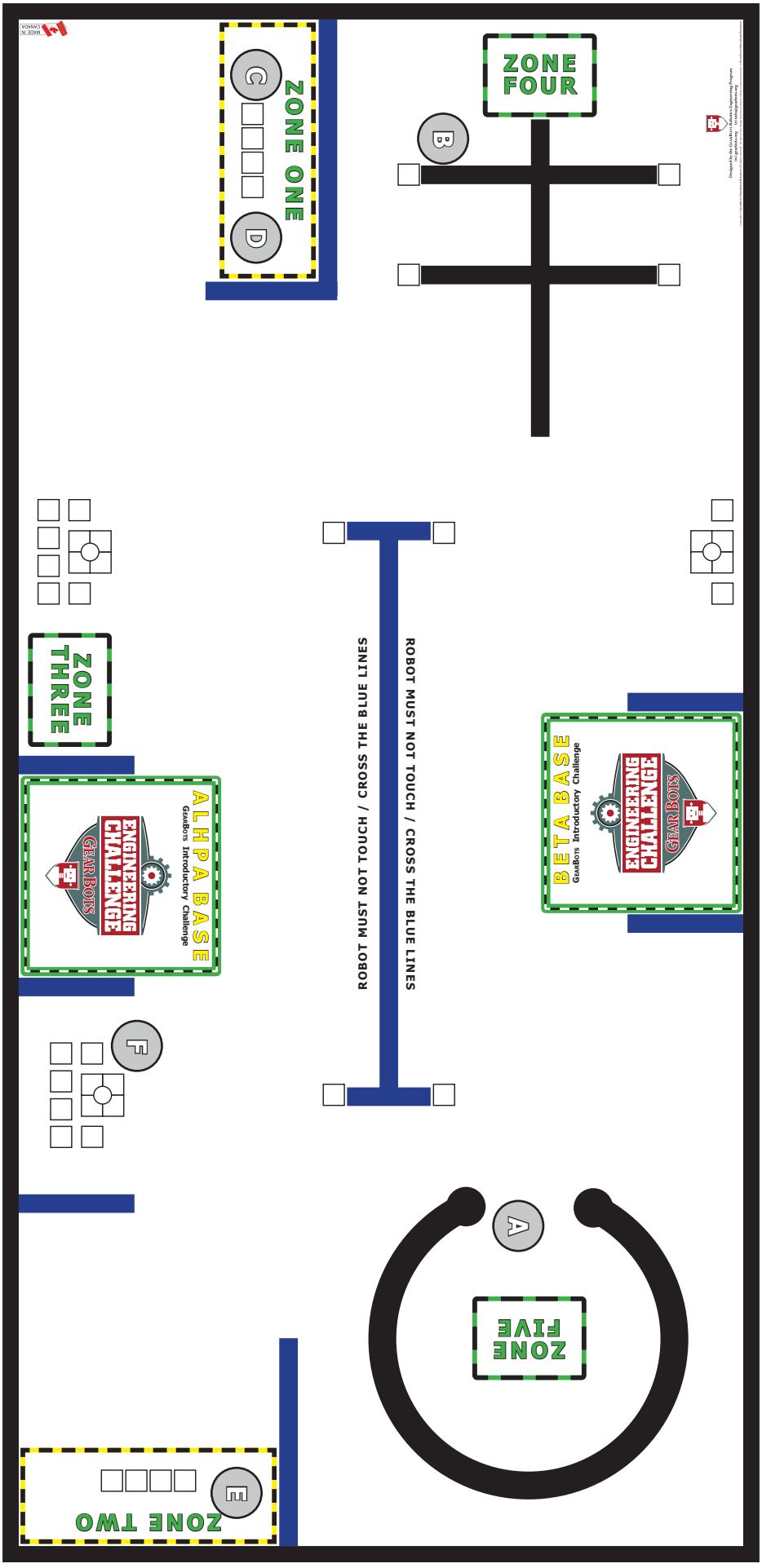
- ☐ **DELTA BASE Primary Mission D: Collect Objects in Drop Zone One**
  Your robotic device must travel from the **DELTA BASE** to **ZONE ONE**, collect the **4 BLOCKS**, push the **4 BLOCKS** to **ZONE FOUR**, and return back to the **DELTA BASE**.

- ☐ **DELTA BASE Primary Mission E: Collect Objects in Drop Zone Two**
  Your robotic device must travel from the **DELTA BASE** to **ZONE TWO**, collect the **4 BLOCKS**, travel to the **BROKEN CIRCLE ZONE**, use a light sensor to follow the line, deliver the **4 BLOCKS** to **ZONE FIVE**, and return back to the **DELTA BASE**.

Extension Mission: Can only attempt this Extension Mission once **ALL** Primary Missions from the **DELTA BASE** have been successfully completed/evaluated by the judges.

- ☐ **DELTA BASE Extension Mission F: Retrieving Object Right of ALPHA BASE**
  Your robotic device must travel from the **DELTA BASE**, travel to the **PICKUP ZONE** to the right of the **ALPHA BASE**, collect the **BLOCKS**, and return back to the **DELTA BASE**.

NOTE: SEE BACK SIDE OF PAGE FOR THE CHALLENGE LAYOUT



NOTE: DIAGRAM NOT TO SCALE

Planning / Pseudo Code Booklet

GEARBOTS Introductory Challenge – CM001

Team Members:

1. _____

2. _____

3. _____

Mission Briefing

Use the Training Challenge Mat - CM001

Description of the Challenges:

1. Missions from the APLHA BASE

☐ **ALPHA BASE Primary Mission A: Travel to the Broken Circle**

Your robotic device must travel from the **ALPHA BASE** to **BROKEN CIRCLE ZONE**, follow the black line using a light sensor program around the **BROKEN CIRCLE ZONE** (as much of the line as you can), and return back to the **ALPHA BASE**.

☐ **ALPHA BASE Primary Mission B: Line Tree**

Your robotic device must travel from the **ALPHA BASE** to the **LINE TREE ZONE**, cross over the first branch and turn at the second / top branch. Use a light sensor to follow the line and return back to the **ALPHA BASE**.

Extension Mission: Can only attempt this Extension Mission once **ALL** Primary Missions from the ALPHA BASE have been successfully completed/evaluated by the judges.

☐ **ALPHA BASE Extension Mission C: Picking Up Ball in Zone One**

Your robotic device must travel from the **ALPHA BASE**, pick up the **BLUE/RED** ball from one of the designated spots from the **ZONE ONE TOWER** located in **ZONE ONE**, deliver/drop the **BLUE/RED** ball into the **CONTAINER** located in **ZONE THREE**, and return back to the **ALPHA BASE**.

2. Missions from the BETA BASE

☐ **BETA BASE Primary Mission D: Collect Objects in Drop Zone One**

Your robotic device must travel from the **BETA BASE** to **ZONE ONE**, collect the **4 BLOCKS**, push the **4 BLOCKS** to **ZONE FOUR**, and return back to the **BETA BASE**.

☐ **BETA BASE Primary Mission E: Collect Objects in Drop Zone Two**

Your robotic device must travel from the **BETA BASE** to **ZONE TWO**, collect the **4 BLOCKS**, travel to the **BROKEN CIRCLE ZONE**, use a light sensor to follow the line, deliver the **4 BLOCKS** to **ZONE FIVE**, and return back to the **BETA BASE**.

Extension Mission: Can only attempt this Extension Mission once **ALL** Primary Missions from the BETA BASE have been successfully completed/evaluated by the judges.

☐ **BETA BASE Extension Mission F: Retrieving Objects Right Of ALPHA BASE**

Your robotic device must travel from the **BETA BASE**, travel to the **PICKUP ZONE** to the right of **ALPHA BASE**, collect **BLOCKS**, and return back to the **BETA BASE**.

Assessment Overview

Use the Training Challenge Mat - CM001

Breakdown of the point system:

Starting a Mission:
- 10 points awarded for starting inside appropriate base

Moving Blocks: (small and large)
- Each designate small block moved or touched during the mission earns 5 points.
- Each designate large block moved or touched during the mission earns 20 points.

Target Boundaries:
- Each block within designated boundary zone but not touching boundary zone will count.
- 5 points for each of the small blocks and 20 points for the large block

Reaching Primary Mission Objective:
- 20 points awarded for the robot reaching the primary mission objective zone

Line Following:
- Following line over as much of the line as they can
- Total points awarded - 40 points (only one direction is counted)

Ending a Mission:
- 10 points awarded for ending inside, or touching the boundary, of the appropriate base
- Running time until mission has been completed.

Extension Missions:
- The ball is worth 100 points. Collect full points if the ball is successfully dropped into the container and the robot returns successfully back to the appropriate base.
- Only 50 points are awarded if the ball does not stay in the container.
- NO points are deducted if the ball tower falls over and touches a NO TOUCH ZONE.

Point Deductions:
- At any point in a mission, 5 points (for each touch) will be deducted for any part of the robotic device (except wires) touching or crossing over the vertical plane or any part of a NO TOUCH ZONE.
- Blocks that touch the NO TOUCH ZONES will be not counted.
- 10 points are deducted when retrieving the robot to restart the mission for each attempt.

Terminating the Mission:
- Touching the robot to correct its course voids (terminates) the mission.
- If the mission has been terminated, the score and time will not count (no points awarded).

1. Missions from the APLHA BASE

ALPHA BASE Primary Mission A: Travel to the Broken Circle
Your robotic device must travel from the ALPHA BASE to BROKEN CIRCLE ZONE ⓘ, follow the black line using a light sensor program (follow as much of the line as you can), and return back to the ALPHA BASE. ⓘ Underlined = primary mission objective

Travel to the Broken Circle Zone *(possible 80 points)*	
Starting inside appropriate base	10 =
Reaching the primary mission objective	20 =
Following the black line (using light sensor)	40 =
Ending inside or touching appropriate base	10 =

Deductions:

Robot crosses over BLUE "NO TOUCH ZONES"	**____ *x 5 = -***
Retrieve robot to restart mission	**____ *x 10 = -***

Total : _____

Time : _____

ALPHA BASE Primary Mission B: Line Tree
Your robotic device must travel from the ALPHA BASE to the LINE TREE ZONE ⓘ, cross over the first branch and turn at the second / top branch. Use a light sensor to follow the line and return back to the ALPHA BASE. ⓘ Underlined = primary mission objective

Line Tree Zone *(possible 80 points)*	
Starting inside appropriate base	10 =
Reaching the primary mission objective	20 =
Following the black line (using light sensor)	40 =
Ending inside or touching appropriate base	10 =

Deductions:

Robot crosses over BLUE "NO TOUCH ZONES"	**____ *x 5 = -***
Retrieve robot to restart mission	**____ *x 10 = -***

Total : _____

Time : _____

Extension Mission: Can only attempt this Extension Mission once **ALL** Primary Missions from the ALPHA BASE have been successfully completed/evaluated by the judges.

ALPHA BASE Extension Mission C: Picking up Ball in Zone One

Your robotic device must travel from the ALPHA BASE, pick up the BLUE/RED ball from one of the designated spots from the ZONE ONE TOWER located in ZONE ONE ⓘ, deliver/drop the BLUE/RED ball into the CONTAINER located in the ZONE THREE, and return back to the ALPHA BASE. ⓘ Underlined = primary mission objective

Picking up Ball in Zone One *(possible 240 points)*

Starting inside appropriate base	10 =
Reaching tower and grabbing or touching ball	100 =
Reaching the primary mission objective	20 =
Successful delivery of ball into container	100 =
Attempted delivery but does not go into container	50 =
Ending inside or touching appropriate base	10 =

Deductions:

Robot crosses over BLUE "NO TOUCH ZONES"	_____ ***x 5 = -***
Retrieve robot to restart mission	_____ ***x 10 = -***

Total : _____

Time : _____

- NO points are deducted if the ball tower falls over and touches a NO TOUCH ZONE

2. Missions from the BETA BASE

BETA BASE Primary Mission D: Collect Objects in Drop Zone One
Your robotic device must travel from the BETA BASE to the ZONE ONE ⓘ, collect the 4 BLOCKS, push the 4 BLOCKS to the ZONE FOUR, and return back to the BETA BASE. ⓘ Underlined = primary mission objective

Collect Objects in Drop Zone One *(possible 100 points)*	
Starting inside appropriate base	10 =
Reaching the primary mission objective	40 =
Number of blocks moved or touched	____ x 5 =
Blocks left touching or in zone four	____ x 5 =
Ending inside or touching appropriate base	10 =

Deductions:

Robot crosses over BLUE "NO TOUCH ZONES"	_____ ***x 5 = -***
Retrieve robot to restart mission	_____ ***x 10 = -***

Total : _____

Time : _____

BETA BASE Primary Mission E: Collect Objects in Drop Zone Two
Your robotic device must travel from the BETA BASE to the ZONE TWO, collect the 4 BLOCKS, travel to the BROKEN CIRCLEⓘ, use a light sensor to follow the line, deliver the 4 BLOCKS to ZONE FIVE, and return back to the BETA BASE.
ⓘ Underlined = primary mission objective

Collect Objects in Drop Zone Two *(possible 140 points)*

Starting inside appropriate base	10 =
Reaching the primary mission objective	40 =
Number of blocks moved or touched	____ x 5 =
Following the black line (using light sensor)	40 =
Blocks within or touching zone five	____ x 5 =
Ending inside or touching appropriate base	10 =

Deductions:

Robot crosses over BLUE "NO TOUCH ZONES"	**_____ *x 5 = -***
Retrieve robot to restart mission	**_____ *x 10 = -***

Total : _____

Time : _____

Extension Mission: Can only attempt this Extension Mission once **ALL** Primary Missions from the BETA BASE have been successfully completed/evaluated by the judges.

BETA BASE Extension Mission F: Retrieving Object Right of ALPHA BASE
Your robotic device must travel from the BETA BASE, travel to the PICKUP ZONEⓘ to the right of ALPHA BASE, collect all the BLOCKS, and return back to the BETA BASE with the blocks. ⓘ Underlined = primary mission objective

Retrieving Object Right of ALPHA BASE *(possible 160 points)*

Starting inside appropriate base	10 =
Reaching the primary mission objective	40 =
Collect the blocks in the zone	____ x 5 =
Delivering the blocks back to the base - Touching or in the base counts	____ x 5 =
Ending inside or touching appropriate base	10 =

Deductions:

Robot crosses over BLUE "NO TOUCH ZONES"	**_____ *x 5 = -***
Retrieve robot to restart mission	**_____ *x 10 = -***

Total : _____

Time : _____

Name: _____ Block: _____ Date: _____

Engineering Logbook

GEARBOTS Educational Resources ~ www.gearbots.org

Engineering Team Members:

1. _____
2. _____
3. _____

Project Title:

Kit Number:

Computer Number:

Logbook Number:

Assessment of Logbook:

- ☐ 1 Not Meeting Expectations
- ☐ 2 Minimally Meeting Expectations
- ☐ 3 Meeting Expectations
- ☐ 4 Exceeding Expectations

/4

Were you present for this class ☐ **YES** ☐ **NO** I was absent.

- If you answered **YES**, complete the following questions:

Engineering Logbook:

This class is DAY _____ of the challenge

Rate your participation today:

1 Not Meeting Expectations 2 Minimally Meeting Expectations 3 Meeting Expectations 4 Exceeding Expectations

	Employability Skills Profile 2000+	1	2	3	4
1	Gives full attention to instructions and follow directions				
2	Comes prepared and works the entire class				
3	Works well with minimal supervision				
4	Works up to potential, shows maximum effort				
5	Works cooperatively as a member of a group				
6	Makes effective use of time and/or materials				
7	Demonstrates initiative and motivation				
8	Has a cooperative, positive attitude				
9	Is on time for class				

1. What did you want to accomplish today?

2. What went well in your team today?

3. What problems did you experience today?

4. What solutions did you try to solve the problem? Did they work? Why or why not?

5. What is your goal for tomorrow's class?

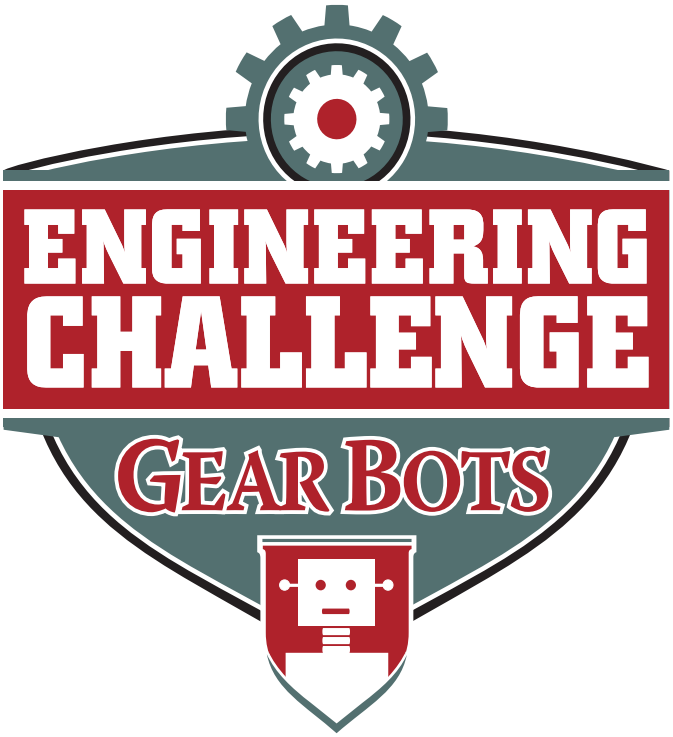
Pseudocode:

Use the space provided to write out the behaviours your robotic device will accomplish during this project. Make sure to print neatly and include any measurements and calculations needed to complete the project.

Continue Pseudocode:

Engineering Methodology Booklet

GEARBOTS Educational Resources

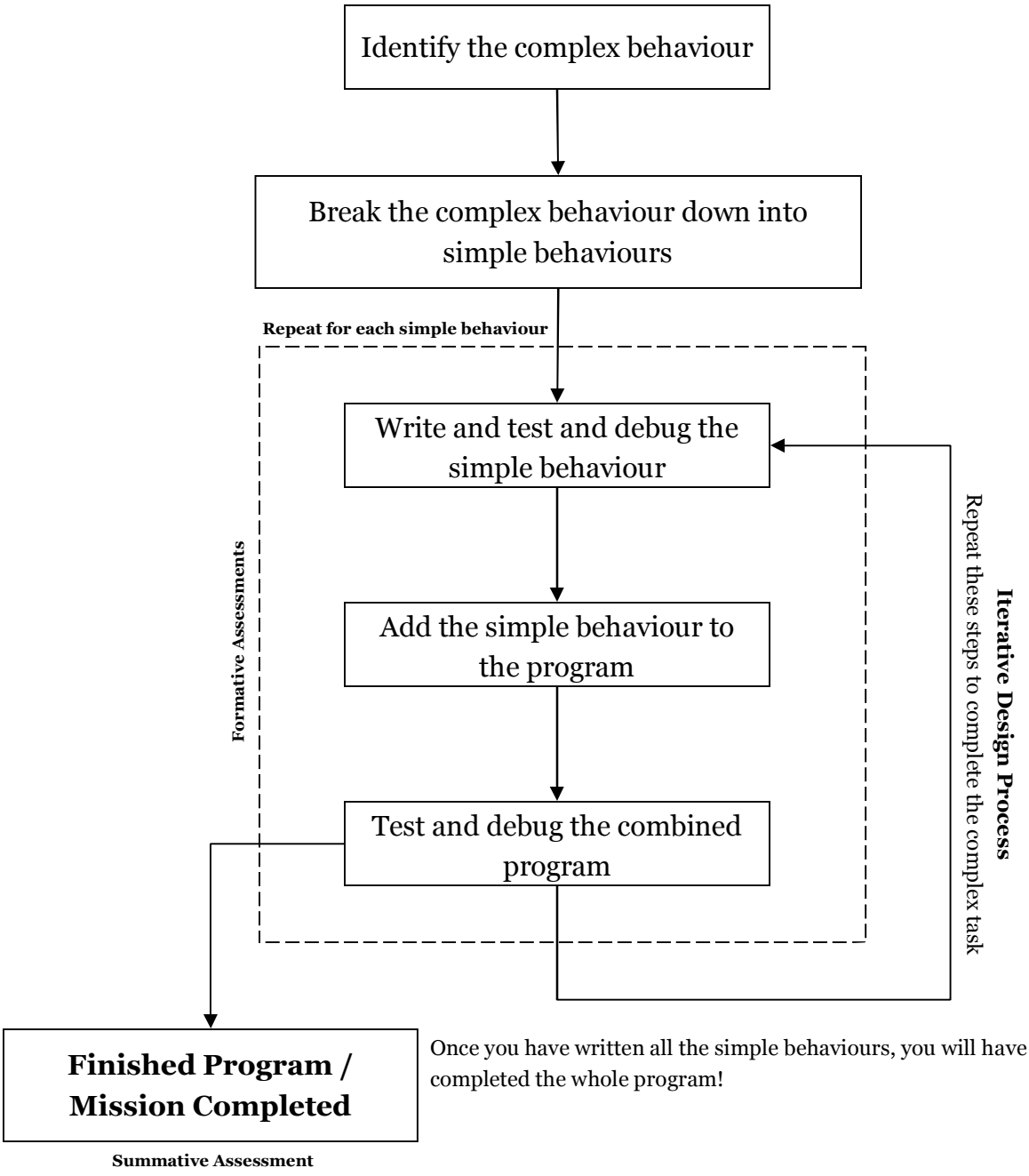


Name: _____ Date: _____

ENGINEERING METHODOLOGY

Robotics / Mechatronics

The easiest way to write a complex program is to break the complex behaviour into smaller, simpler behaviours and write the simple behaviour one at a time, piecing them back together as you develop your program.



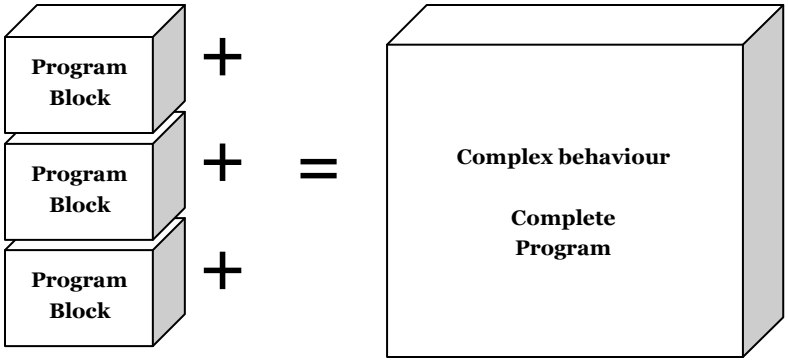
Once you have written all the simple behaviours, you will have completed the whole program!

ITERATIVE DESIGN [AKA: BABY STEPS]

Robotics / Mechatronics

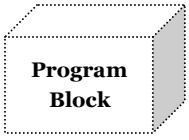
Iterative Design is a methodology often used in engineering. Iterative design is based on a cyclic process of prototyping, testing, analyzing, and refining a product or process. Based on the results of testing, the design is changed and refinements are made. This process is intended to ultimately improve the overall design. The iterative design process is very important in solving the challenges assigned to your team during the course.

Key Terms: Methodology, cyclic process, prototyping, analyzing, refining, behaviour, iterative design

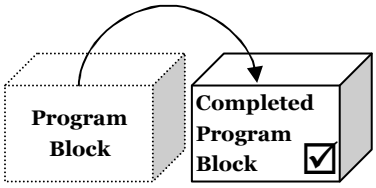


Break the behaviour into simper ones:
Look carefully at the structure of the problem. Try to identify good places to divide the task into parts. Break up long procedures and establish sub-goals where possible.

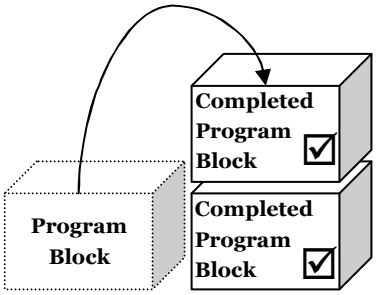
A large programming behaviour will almost always break down into smaller, recognizable ones.



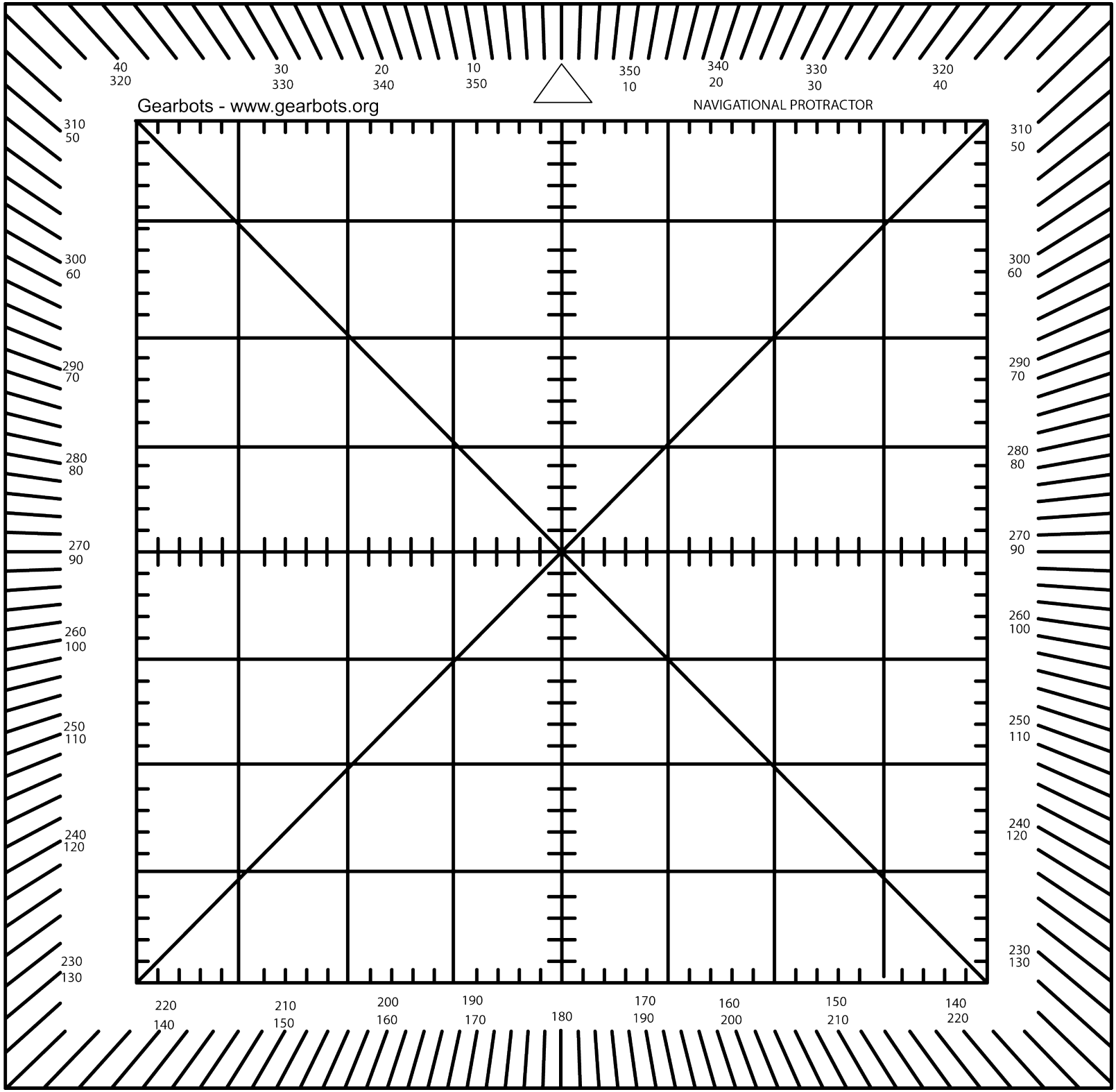
Write and test the simple behaviour:
Choose behaviours you already know or can easily adapt from ones you are familiar with. Test the behaviour to make sure it works on its own.



Add the simple behaviour to the program:
Add the behaviour you just wrote into the appropriate place in the program and start on the next behaviour. Save each step as a separate program.



Test and debug the combined program:
Make sure your behaviour functions as intended with the program. Many times, you will need to adjust it to compensate for the robot's orientation, momentum, or other unforeseen factors.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