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Chapter 1: Introduction

This book is a guide for teachers implementing a robotics unit in the classroom. It is aimed at middle years schooling (ages 9 - 15) but the wide range of activities can be adapted to suit older or younger students. The book is based around the VEX IQ platform, and more specifically a single robot design, the miniVEX, which is used in all activities. Using a single simple robot design approach is valuable in resource limited classrooms, as it allows the teacher to work with a 'standard' robot, rather than using valuable classroom time building and breaking down unique robots each lesson. The miniVEX design can be found at the back of the book, as well as being freely available online - www.damienkee.com. Please send me an email and let me know if you are using the design!

All activities can be completed with the following VEX IQ kits

- VEX IQ Starter Kit with Smart Sensors
- VEX IQ Super Kit
- VEX IQ Starter Kit with Controller + Distance Sensor, Colour Sensor, 2 x Touch LED

This book will focus on the freely available Modkit for VEX software to program the miniVEX.

While the VEX IQ Controller is very useful, this book will focus on learning how to program the robot to behave in a purely autonomous manner. The controller is not necessary for any of these activities.

The book is divided into sections that follow a 10 week plan, although this can be modified to suit the needs of the teacher. The first 6 weeks takes students through a series of activities, progressively exposing them to new aspects of the miniVEX programming environment. Following is a set of open ended challenges from which teachers may pick and choose to suit their particular class.

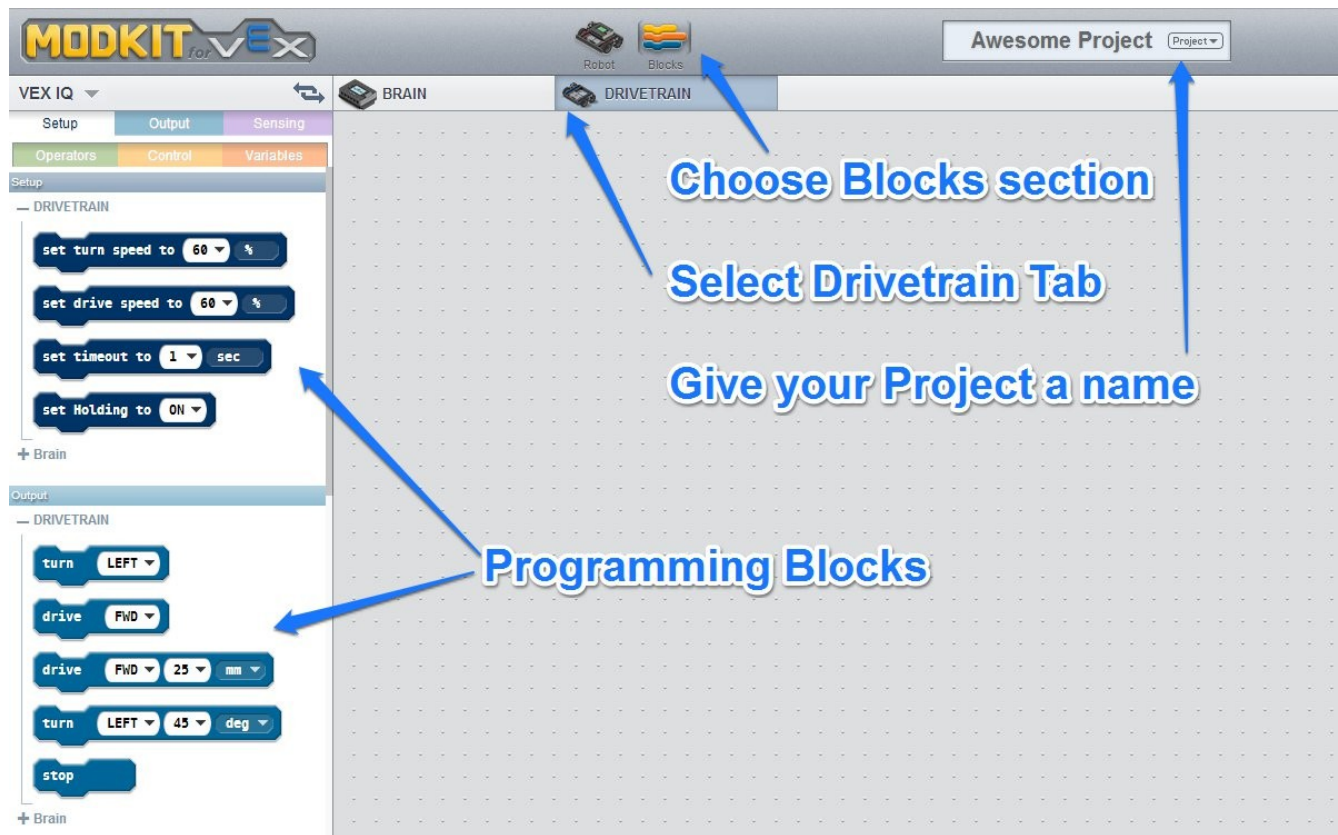
All challenges follow a similar structure:

- Scenario setup + background information. Teachers are free to develop each scenario further as they see fit.
- Equipment list. Aside from the standard VEX IQ robotics kit, all other required resources are easily sourced within a school environment.
- Teacher notes are provided on common issues that may arise with each challenge and how they are best dealt with.
- Programming examples in the VEX IQ Modkit software environment.
- Student worksheets to fill out (photocopy / print permission is provided).
- Extension activities.

Programming the miniVEX

Once we have setup the Robot configuration, click on the Blocks section to change to the Programming Environment. A powerful feature of the VEX IQ system is that each component, be it a Robot Brain, Smart Motor or Smart Sensor can be individually programmed to perform a series of instructions. For these lessons however, we will keep it quite straight forward and stick with programming just the Drivetrain. Ensure that the Drivetrain Tab is selected before you start placing programming blocks.

On the left hand side of the Block section, you will see a variety of different programming instructions. These are the blocks that tell the miniVEX what it needs to do.



The blocks on the left hand side are the instructions for the robot. They are grouped according to what they do, Setup the Smart Motors/ Smart Sensors, Control the Smart Motors/Smart Sensors, read and react to Smart Sensors, modify data, control the flow of a program and manipulate variables

Chapter 3: What is a Robot?

Overview: Discover what a robot is, and what function it performs.

Project: Students are asked about what they think a robot is, and what it does. Students research robots in general and present a report based on one specific robot.



Equipment required

- Access to research materials, (Library, Internet etc)
- Computer to write report

Teachers' Notes

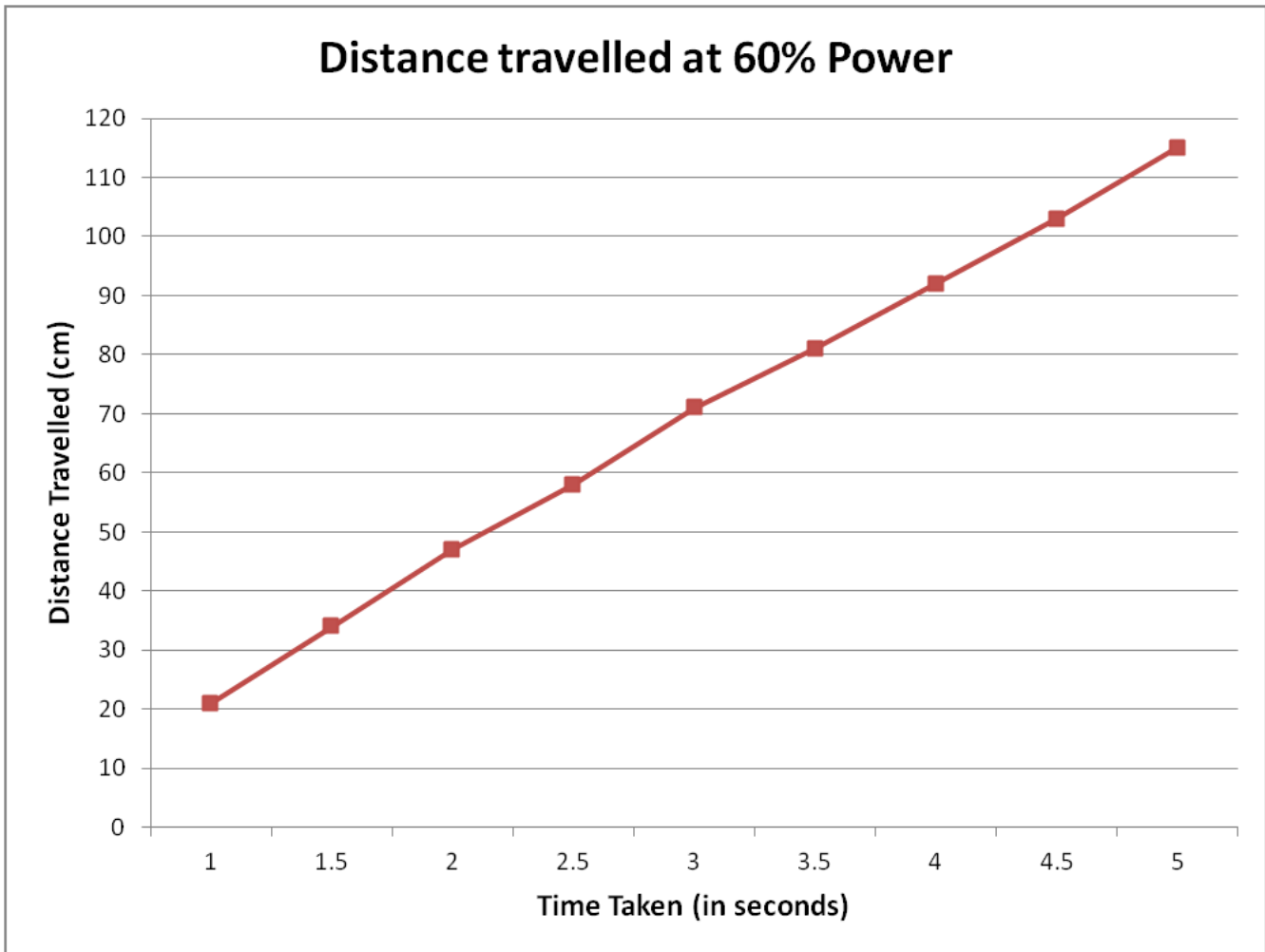
This section will cover the following concepts

- Research skills
- Report writing
- Word Processing
- Design with Multimedia
- Oral presentation

Photocopy or print Student Handout – *What is a Robot?* and distribute to the class. You may choose to start discussion immediately or give the students time to perform preliminary research. Bring the group together and start to form a class opinion of robots.

Pose the following questions to the group.

- What is a robot?
- Where did the term 'robot' come from?
- Name some types of robots
- Why do we have robots? / What function do they perform in society?
- What are the main components of a robot?



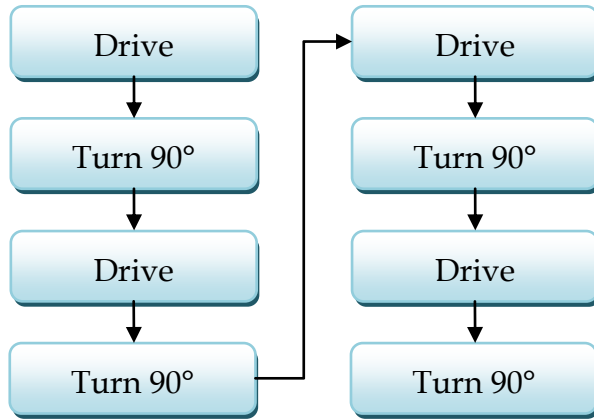
Look out for...

To set up, we will need a starting line and a tape measure. Encourage the students to work out what materials they will need and gently push them in the right direction if they miss out on anything.

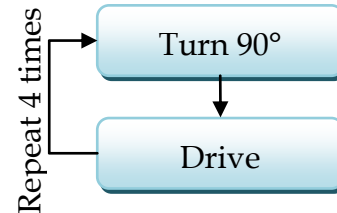
If this same experiment is run on carpet, students can expect to see a decrease in the distance of the robot due to the additional friction between the castor wheel and the carpet surface. Encourage this line of thought and get the students to run the same experiment with the same power level on multiple surfaces.

Be wary of very high power levels. Depending on the surface the robot is travelling on, sometimes the wheels can 'slip' as they start up, giving a slightly shorter distance than should be measured.

To make our robot drive in a square, we will need to program it to go forward, turn 90 degrees, go forward, turn 90 degrees, go forward, turn 90 degrees, go forward and do a final 90 degree turn. If we look carefully at the program, we can see that it consists of drive forward, turn 90 degrees and repeated 4 times.



Option 1



Option 2

Driving in a square. Which is easier?

We can use the **Repeat** Block to achieve this simpler form of programming. Everything within the border of the **Repeat** Block will get repeated based on the values we specify.

Example Program

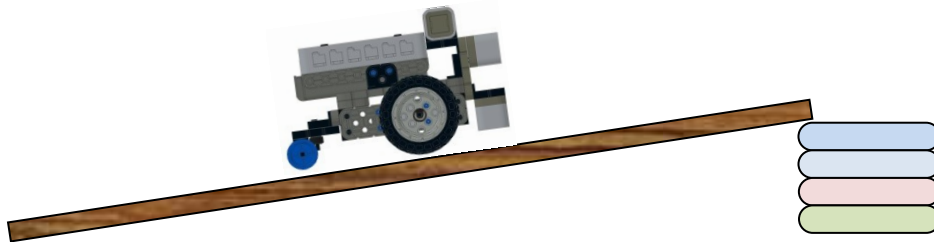
Make your Robot drive in a square.



Chapter 12: Going Up and Going Down

Overview: Use the Gyro Sensor to keep track of the steepness of the terrain.

Project: NASA has discovered a good deposit of minerals in a valley far below. Your robot design can only safely ascend slopes of 20 degrees, any more and there is a very real risk that the robot will topple over. Devise a program that will enable the robot to drive along a slope, but stop and reverse if it becomes too steep.



Equipment required

- 1 VEX IQ robot kit per group
- 1 computer per group
- A ramp with the ability to vary the angle of slope. This could be as simple as a wooden plank and several books.

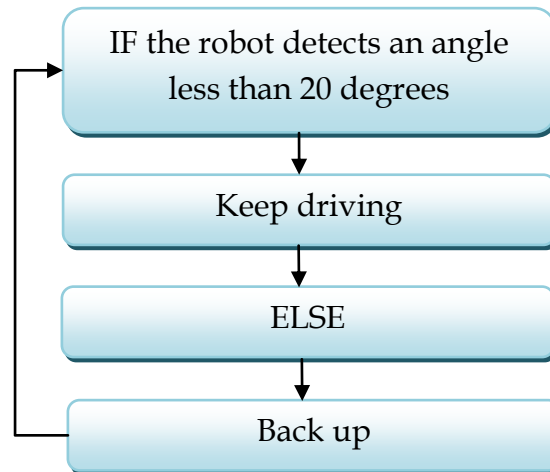
Teacher Notes

The Gyro Sensor is capable of measuring when it is being rotated. The common way of using the Gyro is to mount it so the 'z' label is facing up, and then using it to measure how far the robot turns. For this challenge we will be mounting the Gyro sideways (so the 'z' is pointing sideways) and using it to measure if the robot is going up or down a slope. For this chapter, we have connected the Gyro Sensor to port 1. Go to the Robot section, drag in a Gyro Sensor and set it to Port 1

NB. Make sure the Gyro has the 'z' pointing to the right-hand side of the robot. This ensures that as the robot goes up an incline, it will measure the gyro as increasing. If the Gyro is placed on the left-hand side, the robot going up an incline results in negative gyro values.



We will again use the IF-ELSE block to solve this challenge.



```
when START
  forever
    clear LCD
    print GYRO angle in deg
    if GYRO angle in deg < 20
      drive FWD
    else
      drive REV
```

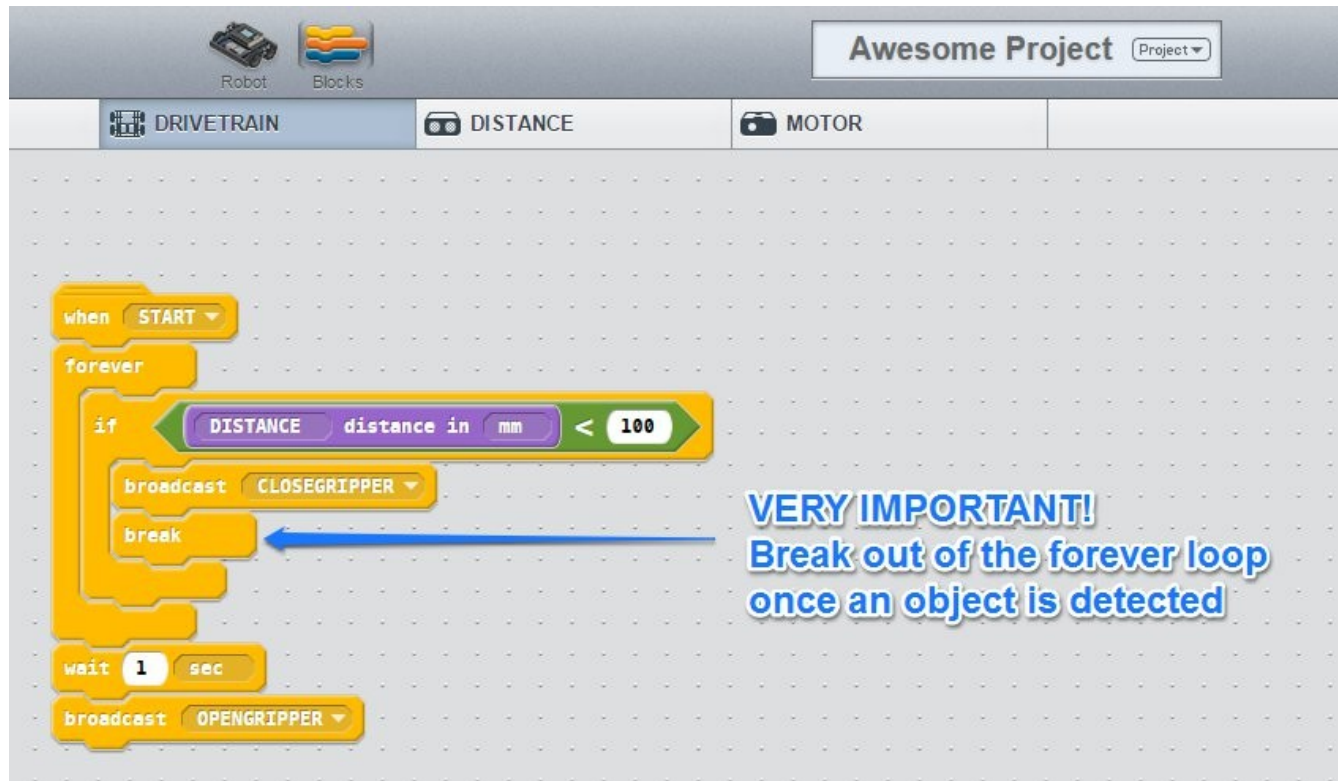
TIP: The Gyro can be extremely sensitive. It is important that the Gyro is extremely still whenever it is plugged in. When using the Gyro for the first time with a program, it is always handy to plug it in, place it on a stable surface so it is still, and then turn the VEX IQ Robot Brain on. If you continue to run into problems with the Gyro, sometimes it helps to unplug and re-plug the sensor back into the VEX IQ Robot Brain to reset it.

There are ways of improving the accuracy of the Gyro. Click on the Gyro Tab for the blocks and investigate the 'calibrate' Block

See an object and grab

Let's now introduce the Distance Sensor and see if we can make the Gripper close when it senses an object.

***IF the Distance Sensor sees an object less than 100mm
Broadcast "CLOSEGRIPPER"
Repeat forever***



You'll notice a new block in this example that we haven't used before. The *break* command is used when we want to break out of a *forever*, *while* or *repeat* loop if needed. If we don't use this block, the miniVEX will recognise that an object is in sight and close the Gripper 90 degrees. The forever loop would then force the robot to check again if an object is in sight and make the Gripper close another 90 degrees. As long as an object is within 100mm, the gripper would keep running the CLOSEGRIPPER command. By placing the *break* command straight after CLOSEGRIPPER command, the program exits out of the Forever loop and can proceed on to the next set of command, namely the *wait 1 second* and *broadcast OPENGRIPPER* blocks.

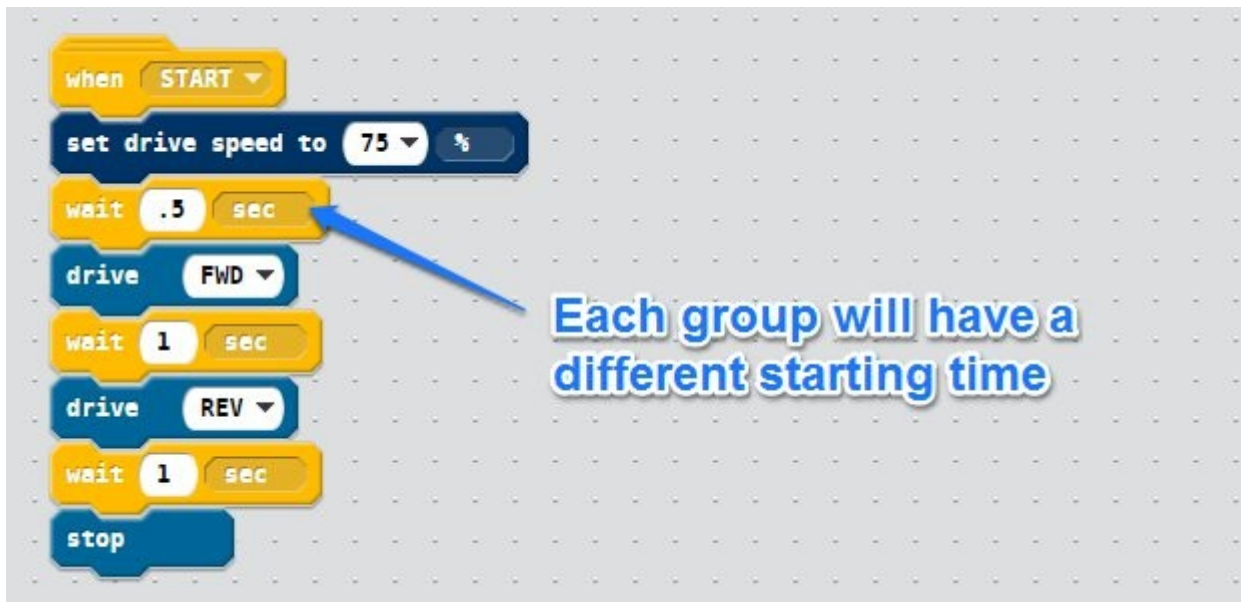
When using a 0.5 second delay between each robot, the required 'wait' time is half the group number. eg. Group 5 will need to wait for 2.5 seconds.

Once the initial wave has been mastered, it is possible to extend the number of motions that each robot performs. Rather than the basic 'Drive forward, Drive backward', try these different combinations or leave it to the group to devise their own choreography.

- Forward 1 second fast, Backward 1 second slow
- Forward 1 second, Backward 2 second, Forward 1 second
- Forward 1 second, Backward 2 second, Forward 1 second, Loop the whole procedure 4 times
- Arrange the robots in a circle rather than a straight line

Example Program

This program describes the basic Robot wave program



Extension Activities

Up and Back

Have the wave progress up the line, and then come back down the line to the starting robot. This will require some careful planning to ensure each robot knows how long to wait before performing their 2nd wave.

Cheerleaders

Add extra Smart Motors to the robot to create some arms with pom-poms. Run the Robot wave using these pom-poms as well.

How far?

Group Name _____

Group Members _____

Project: In the initial construction of the robot the travelling characteristics are required. After characterising the properties, NASA have asked that you use your data to make predictions about the distance your robot will travel given specific time constraints.

Your group will be assigned a random power level to be assessed.

Power Level Assigned _____

For this experiment you will need to measure how far the robot travels for different time values (eg. 1 second, 2 seconds, 3.5 seconds etc). The more data you gather, the more accurate your graph will be.

Plot the results either on the graph below or in a graphing software package.

(Hint: you will need to know the smallest and largest times you tested for, as well as the smallest and largest distances so that you can determine the horizontal and vertical axis scales)

Once you have plotted your data, can you see a relationship between the time taken and the distance travelled?

By looking at the graph, can you determine how many seconds your robot would need to travel exactly 30cm (12 inches)? _____ seconds

How about 1.5m (59 inches)? _____ seconds

Your teacher will assign you a test distance. How long does your robot need to travel this particular distance?

Test Distance = _____

Time required = _____ seconds

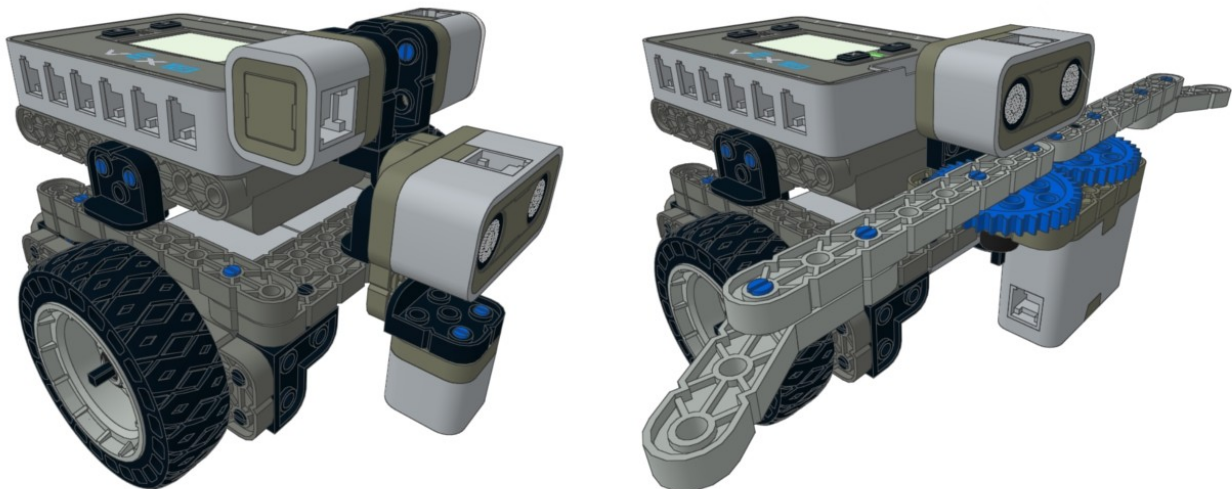
Chapter 22: Building Instructions

These building instructions complement the activities in the book. However, if your students have time, they may wish to attempt their own builds before looking at these designs. All building instructions can also be downloaded in high resolution colour PDF document for printing or viewing on a computer or tablet. If you have the Pre-Summer 2014 VEX IQ kit, it has a slightly different assortment of parts. Pre-summer 2014 kits have maroon pins and gears where as the post-summer 2014 have blue pins and gears. Contact me directly for Building Instructions for the pre-summer 2014 building instructions.

All instructions can be found, downloaded and printed from:

www.damienkee.com

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